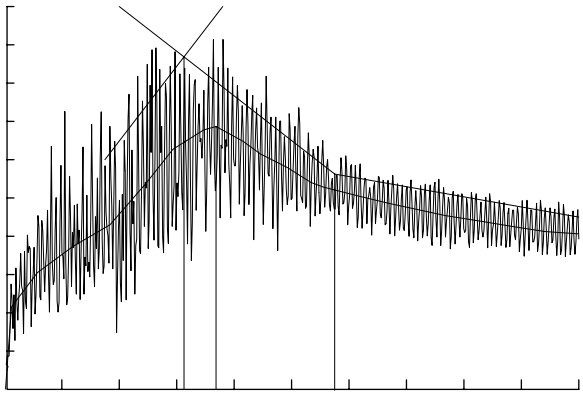
Documentation and User's Instructions

for

MIXSMART®

For Windows

Computerized Data Acquisition and Analysis
For the Mixograph



by

A. E. Walker and C. E. Walker

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Cereal Chemistry Equipment

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MIXSMART For Windows Computerized Data Acquisition and Analysis For the Mixograph, by A. E. Walker and C. E. Walker

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National Manfacturing is pleased to offer a companion volume to this one:

The Mixograph Handbook

This practical collection of laboratory techniques, case studies, standard methods, and moisture tables is shipped with each new Mixograph.

Also available separately from National, this document is a valuable addition to any laboratory or production facility as it gathers into one place over fifty years of experience in the use of this instrument.

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Preface

Welcome to the first full Windows version of the MixSmart analytical software. This upgrade (really a full rewrite) has been a long time coming and I wish to thank all those customers who have been so patient with us (the rest of you know who you are). Seriously, I think you will find it worth the wait.

This latest manual and the new software it describes-- almost a full year in development-- incorporate all of the advanced analytical features added to MixSmart v4.0 (the last DOS release), integrated into the modern and more intuitive Windows environment.

Ok, that was the official line, but the grudging truth from a die-hard bit twiddler like myself is that Windows really does make some things easier. It takes a lot more computer horsepower than a DOS program and it is still not as stable, but some things like versatile graphics and large-scale memory handling almost make up for all of its fluff and pointless features (What I think of Windows 'Themes' is not fit for polite company).

Actually, my biggest objection to Windows from a programmer's point of view is the sense of being removed from what's really going on. When something didn't work during this last development cycle, it was so much easier to blame the intervening abstractions than to actually find out what I had fouled up. Given that, I can't promise you this package won't have a few undocumented features and maybe (if you are very lucky) a tiny a bug or two, but overall this new release should be just what the doctor ordered (or PhD, actually—and quite a lot of them).

MixSmart For Windows is also the first version to use the new ADCComm serial port based interface chassis. This unit is required to collect data under the new software and replaces the old SGA/ADC-P2 box which tied the user to a DOS-mode only parallel port interface.

In the interest of simplification, we have also eliminated the parallel port security key which was required by the older versions.

Let us know how it all works for you and how we can improve the product.

A.E. Walker

December, 2003
Lincoln, NE

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Chapter 1

Program Features in Brief

The previous versions of this package were DOS based with a long legacy and a loyal following. However, the world has changed much since MixSmart was introduced more than a dozen years ago. User's have become more sophisticated and many of the features which were originally difficult to implement and necessarily proprietary are now absorbed by the ubiquitous Windows interface standard. Bowing to this trend and the growing sophistication of our customers, this edition of the user's manual strives to eliminate the more elementary instructions found in the previous editions and instead concentrate on the powerful analytical features unique to this product.

1.1 Computer System Requirements and Performance

MixSmart For Windows benefits from all the performance tweaks of any Windows program. A faster processor, a faster hard drive, and more memory is always good, but MixSmart will also work quite well on machines which are not cutting edge. Development and testing was principally carried out on an AMD K6/2-400mhz computer running Windows 98se and having 128 megabytes of ram. Even so, data collection worked quite well at any reasonable rate of acquisition and normal data analysis required only a few seconds.

The installation requires less than 10 Megabytes on disk-- including enough storage for hundreds of raw data files and final (text) reports. Be aware, however, that if the 'Picture to File' option is enabled, considerable disk storage is required. In this mode an analytical image file is created for each run. On a 24 bit color system the BMP graphics files thus created occupy almost 600k each when the main program screen is set to 'normal' size. If the screen is set to maximum size on a high resolution display system, image files of over 3.5m each are possible Users with limited drive space may wish to leave the 'Picture to File' option disabled or periodically remove the BMP files from the reports directory.

1.2 The User Interface

The user interface has evolved with this version to a full MS-Windows format. Users should find the menu layout, descriptions, and various button functions both intuitive and more efficient than the DOS versions. In acknowledgement of the extensive file management tools already present in Windows, the file archive and publishing utilities which were added to version 4.0 of the DOS

software have been eliminated from the Windows version. For convenience, however, most file types can still be renamed and deleted from within MixSmart For Windows.

Possibly the most noticeable change to the file handling operations in MixSmart is the addition of support for long file names. While this feature is standard amongst modern Windows packages, it should still be used judiciously. Very long names can be confusing and sometimes cause formatting problems on the reports.

1.3 Data Acquisition

The ADCComm analog interface supplied with your computerized Mixograph (or with the retrofit kit) is meant to attach to your computer's serial port via a simple DB9 cable (included). Note that the new kit must be not be connected to the parallel printer port as the old SGA/ADC-P2 did. Most users should have a free serial port on their computer. Those who may not can usually install a Serial-to-USB converter on a USB port. These have been shown to work fine with the new interface

Warning

The ADCComm unit includes two or more DB9 connectors. It is absolutely imperative that only the one marked 'Computer' be attached to the host computer. The other DB9 connector(s) attach to the analog signal cable from the Mixograph or other National instruments. Interchanging these lines may damage the computer, the interface, or both.

The older SGA/ADC-P2 interface can not be used with MixSmart For Windows. Likewise the Metrabyte DAS series boards or the CIO compatible equivalents from Computer Boards are no longer supported. Full installation instructions for the supplied electronics are provided in Section 3.1.

The supplied interface has a low pass filter in it to eliminate analog data above 25 Hz. Experiments have shown that no meaningful information exists in this region, but it does contribute substantially to baseline noise. By disabling the low pass filter on the supplied interface, much higher collection speeds are possible. Using a modified interface, samples have been collected at over 100 Hz. The effect of sampling frequency on Mixograph data collection is addressed in some detail in Chapter 15.

The minimum and maximum plot range (corresponding to 0% and 100% mixogram scale) can be set, and will be saved with the data file. The program also provides the means to change the min/max values after a curve has been recorded.

Data Collection can be triggered manually by the keyboard or mouse; or by detecting changes in the ADC signal when the Mixograph Motor is turned on.

The later two gram Mixographs and the new direct drive Mixographs are (or will eventually be) controlled by the software directly.

1.4 File Control and Routing

Full path names can be chosen from a directory traversal list or new directories created for data, report, and spreadsheet file directories. Data files can be saved in a fast, highly efficient, binary format or in an ASCII form accessible to spreadsheets and word processors.

Report files are usually saved as simple text files and the screen plot itself can be automatically saved as a 'BMP' file.

1.5 Data Analysis

Data analysis may follow immediately after collection, or at any time in the future, and may be repeated with different curve fitting parameters. Re-analysis of large numbers of files can be performed automatically, via the batch file options. Reports may be sent to the screen, a disk file, printer, or in any combination. The report images can be printed either during analysis or afterwards to any Windows compatible printer. Images will print in color when it is available.

Both mid line and envelope analyses are performed. The mid line analysis includes peak time and height, as well as heights at different times to left and to right of peak. The height at a user selected, arbitrary time X, and at the tail (end of analysis) are provided. The ascending and descending slopes (left and right of peak) and tail slope are reported, and the area under the mid line is determined from the origin to these points. (Mid line area is proportional to work input.)

The envelope analysis places curves along the top and bottom of the plot and determines top-line peak time, peak height, ascending and descending slopes, bandwidth, and area (of the envelope region) at several locations.

Whether or not these various analyses are performed (and shown on the print out) is menu controlled. The curve fitting parameters are adjustable (although standard values are suggested). The portion of the curves to be analyzed is also adjustable making it possible to ignore part of the initial and/or tail sections if they are irregular.

The MIXSMART.INI file (or any other profile) which loads at program start, holds the user's preferences for most settings. Some of this information is also stored with the curve when it is recorded (for use during analysis) and all settings can be temporarily over-ridden by the batch file procedures.

Like the final DOS version before it, MixSmart For Windows includes a powerful, imbedded procedural programming language. This allows the user to develop (or have National develop) custom analysis modules and reports. These can range from simple Go/No-Go warnings on the finished analysis screen to completely new analytical add-ons to the report system. Examples and instructions included with this manual allow the obsolete 'Envelope Area' analysis to be added back in to the new system as the EnvelopeArea.PGM module option. Similarly, mid line style analyses can also be applied to the top or bottom envelope curves by using the MIDLINE.PGM module.

One other included .PGM module is worth noting here. The Mixograph absorption prediction system developed by C. E. Walker et. al. is available as ABSPRED.PGM.

Some typical reports are included in this booklet. Note that the "tightness" of the envelope and the smoothness of top, mid, and bottom curves are adjustable by the curve fitting parameters mentioned earlier. Likewise, the region over which the slopes are determined can be adjusted. The default values used here have been found to be satisfactory, but are not guaranteed to be the best for all users or all flours.

Chapter 2

Getting Started

2.1 Installing the Software

MixSmart requires formal installation using the included 'setup' program. The next few pages describe the use of this utility.

Before beginning the actual installation process make sure that your software kit includes a manual (about 190 pages in a comb binder), one CD-Rom disk, a DB9 cable, an ADCComm interface box, and a power cord suitable for your electrical grid. Be sure to store the CD-Rom in a safe place after installation. It contains supplemental files which may be needed later and also includes the 'uninstall' utility.

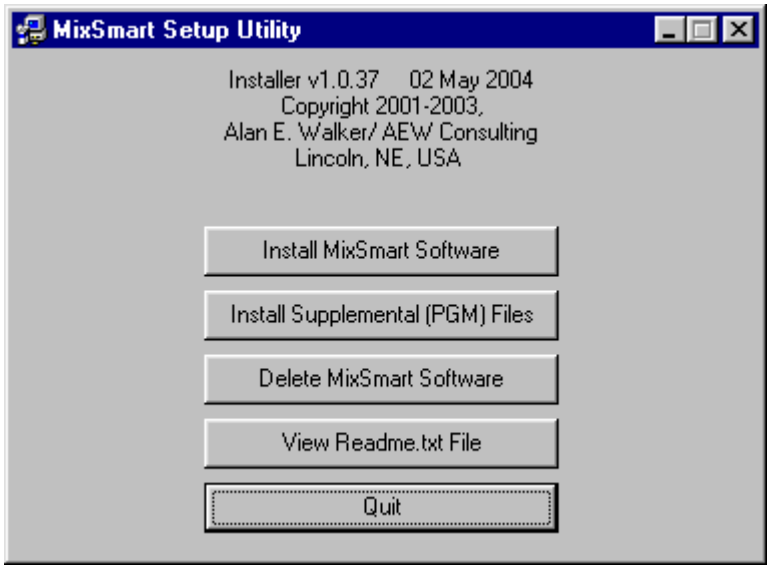
We assume that most users are running Windows 98, Windows Me, Windows 2000, or Windows XP. MixSmart will also install and run under Windows 95 or Windows NT 4.0, but these older operating systems sometimes require updating the standard Microsoft run time packages (this is done automatically by the setup program). In rare cases, it may also be necessary to install Internet Explorer 5.0 or later to eliminate some Active-X errors during installation.

MixSmart For Windows and its setup program will run under any screen resolution and at any color depth, however we recommend 800x600 or higher and a color depth of 24bits or higher.

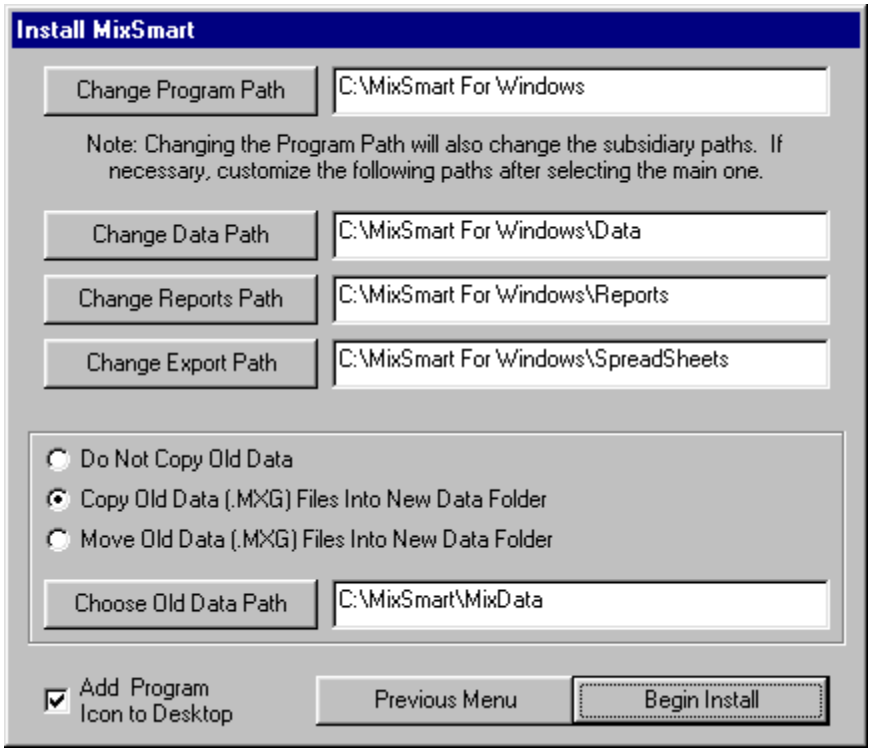
Warning

In order to successfully install this program, users of Windows NT 4, Windows 2000, and Windows XP must be logged in with administrative rights.

Setup should launch as soon as the CD is inserted. If it does not then choose 'run' from the computer's start menu and enter 'D:\setup' to begin the installation process (where 'D' is the system's CD-ROM drive letter):

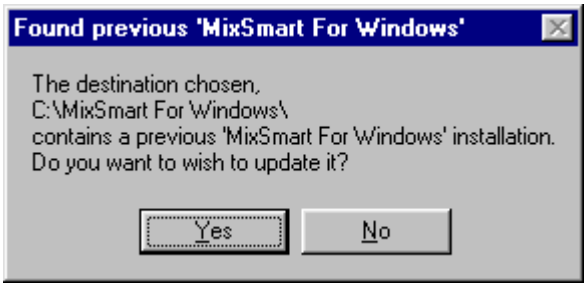


Choosing 'Install..' brings up the next menu:

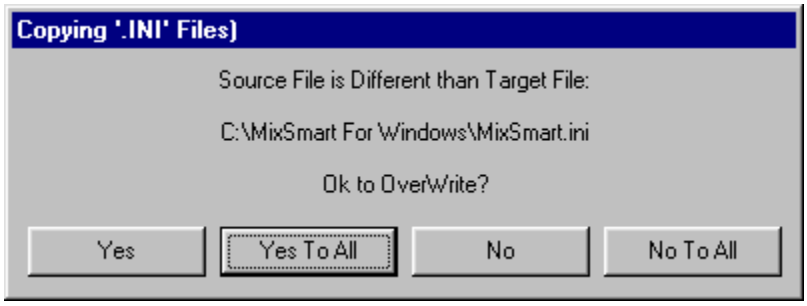


In general it is suggested that the defaults be used. Note, however, that the boxed options on this screen allow the user to automatically migrate existing

data files into the new data folder. This option is offered by default only if old data sets are found at 'C:\MixSmart\MixData' and if no current installation is found at 'C:\MixSmart for Windows'. Whether selected by default or not, the user may also browse for old data to migrate into the new folders and adjust the settings on this screen to set the main and data directories for the new software. When any adjustments are completed, choose 'begin install'. If the destination directory is already present, a warning is made about overwriting existing files.

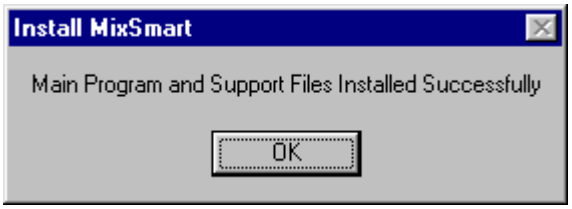


At this point Setup will display a progress bar and start copying the files needed from the source drive (typically D:) to the MixSmart For Windows directory on the target drive. This directory will be created if it does not exist. The user is given the option of replacing any existing .INI (defaults profile) files:



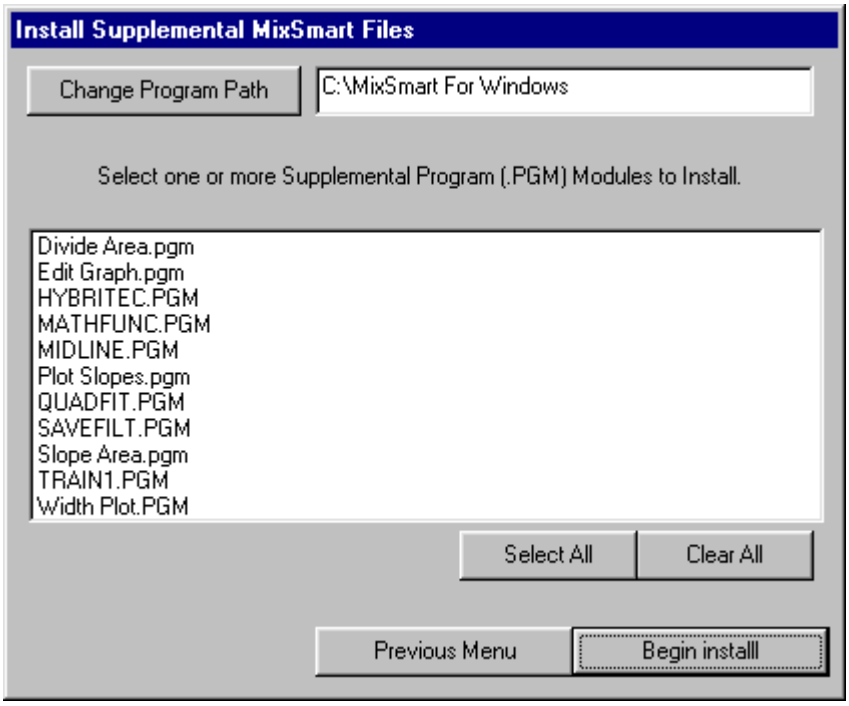
User created data sets, reports, spreadsheets, batch files, and PGM modules, in the target directory should remain unchanged unless they carry the same name as one of the system or sample files in which case they will be lost. Previous (DOS) version profiles, modules, report files, batch files, and export templates are not directly compatible with MixSmart For Windows. For this reason, Setup will not allow installation to a directory which appears to contain a DOS version of MixSmart.

A successful standard installation will end with the following message:



At this point, clicking 'OK' will return the user to the Setup main menu where the user may elect to install supplemental PGM modules or view the ReadMe.txt file.

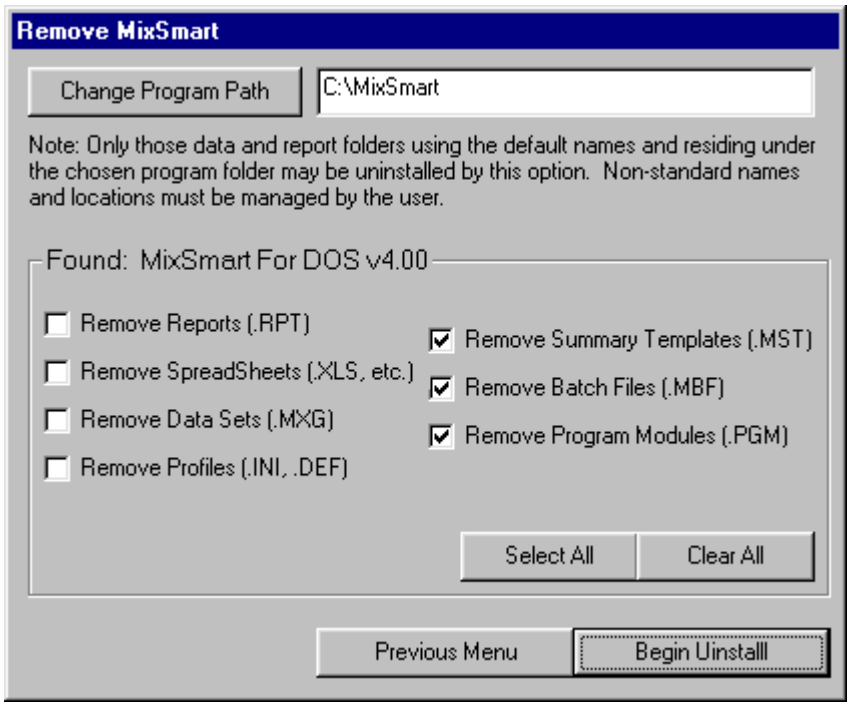
Users wishing to install the Supplemental PGM modules may select them by clicking the appropriate menu button and selecting the desired modules from a list:



When all desired features of MixSmart For Windows have been installed, choose 'quit' to return to the Windows desktop. The program may now be launched from the 'MixSmart For Windows' desktop Icon or via the Start Menu→Programs→National folder:

2.2 Uninstalling MixSmart

The setup utility can also be used to remove the MixSmart software (including older, DOS versions). This option is presented at this time for completeness only. Removal of older versions of MixSmart is not necessary to install a new version and should not be done until the new version is well settled in and all of the old reports and data have been safely archived. In most cases, an update to an existing Windows version of MixSmart will simply overlay the previous version, leaving nothing to uninstall.



If a DOS version of MixSmart is found at 'C:\MixSmart' it will be presented here for removal. If a DOS version is not found then 'C:\MixSmart For Windows' is checked and displayed, if present. If MixSmart is to be deleted using these tools, be certain the correct installation folder has been chosen for destruction. Checking all of the optional boxes will entirely remove a standard install—its folders, files, and shortcuts.

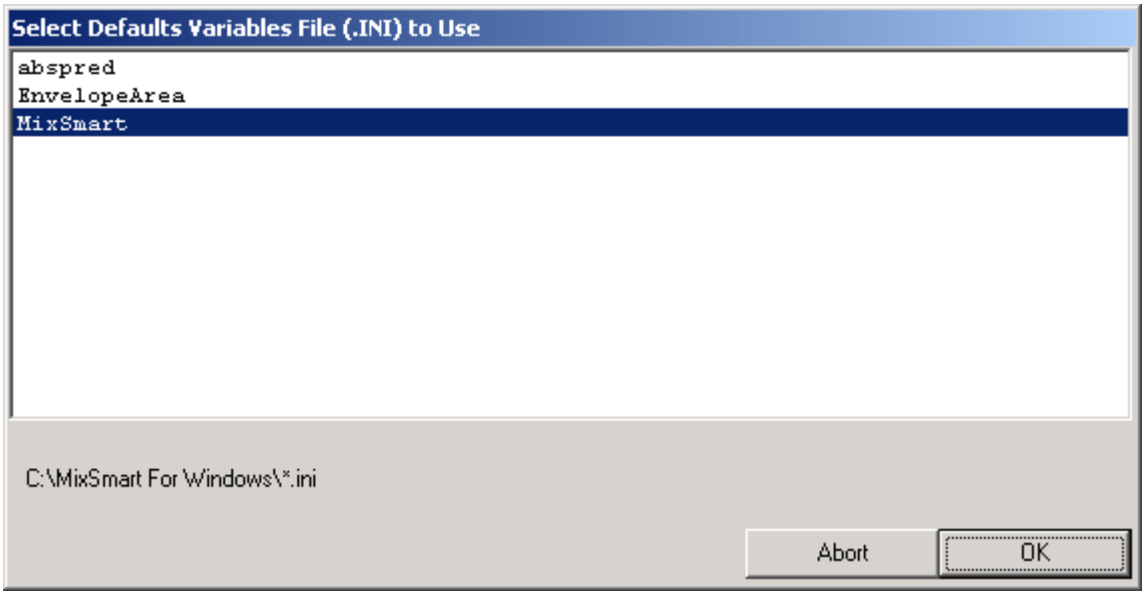
If a user has stored data in a non-standard place or created non-standard folders in the target program folder, then it may not be possible to completely remove a program from here. Generally this is not a problem. Just as in the installation procedures above, full administrative privileges are required to run this utility under Windows NT 4, Windows 2000, or Windows XP.

Warning

The uninstaller does not buffer deleted files to the recycle bin. Once removed they are gone forever. Be certain of what you erase.

2.3 Running MixSmart

Upon launching MixSmart, the user is required to select a configuration profile:



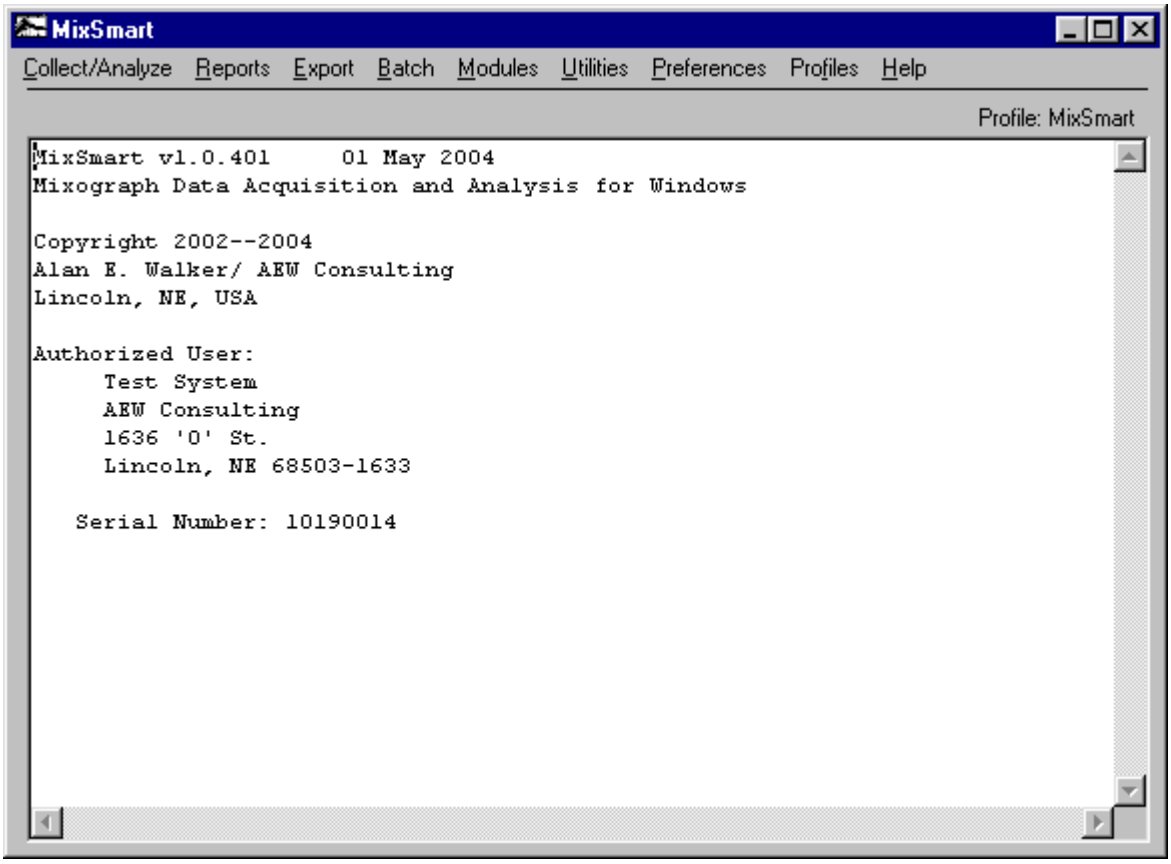
'MixSmart' is normally the factory provided all-defaults file. It is also the .INI name highlighted if none have ever been loaded or if the previously loaded file has been deleted. While it is a good starting point for user's work, It is strongly recommended that a new (project specific or user specific) .INI file be created using the profiles manager as soon as possible (see Chapter 11).

It is actually possible to specify the .INI file from the MixSmart command line, bypassing this menu. For example, changing the command line to:

MIXSMART.EXE /INI ABSPRED

Will automatically load the absorption predictor profile (and ABSPRED.PGM which is pulled in by the profile). This and the other command line options are further discussed in Section 7.3.

After selecting and loading the preferences, the copyright screen and main menu come up:



From the user's viewpoint, MixSmart is a standard Windows program with a nested menu structure running along the top edge and a main or work screen in the center of the application. The menus are described in detail throughout this manual.

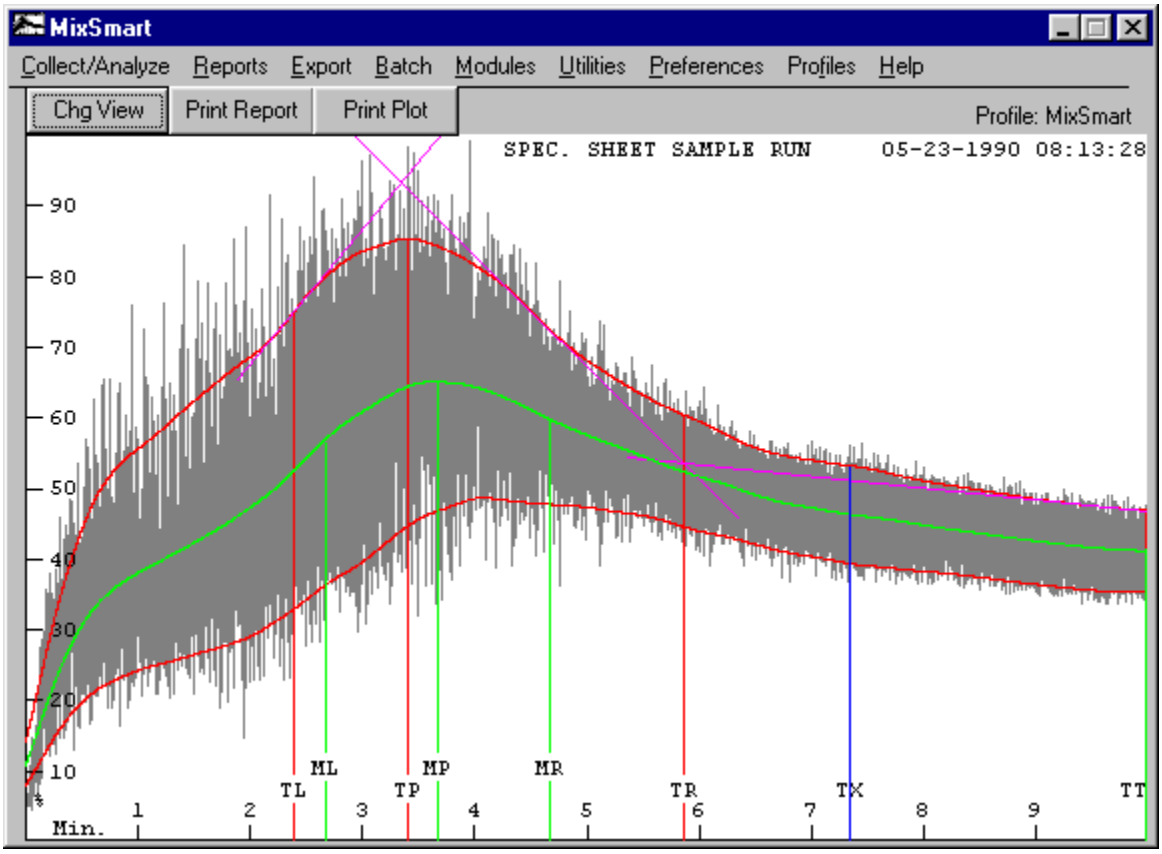
The control variables are explained in detail in Chapter 10. However, some of them, which may need to be adjusted before running the sample analysis, are mentioned in the next part of this chapter. Other variables will need to be examined and possibly changed before collecting your first new data set in Chapter 3.

2.4 Analyzing a Sample Data File

As a check on the computer system, and on your software's safe arrival, run a practice re-analysis on the sample file included with your program disk. Launch MixSmart For Windows, select the 'MixSmart' default user profile, and click 'OK'.

Under the 'Collect/Analyze Menu' select 'ReAnalyze'. Choose the 'Sample' data file and click 'OK'.

The data file will load, analyze, and plot on the screen:



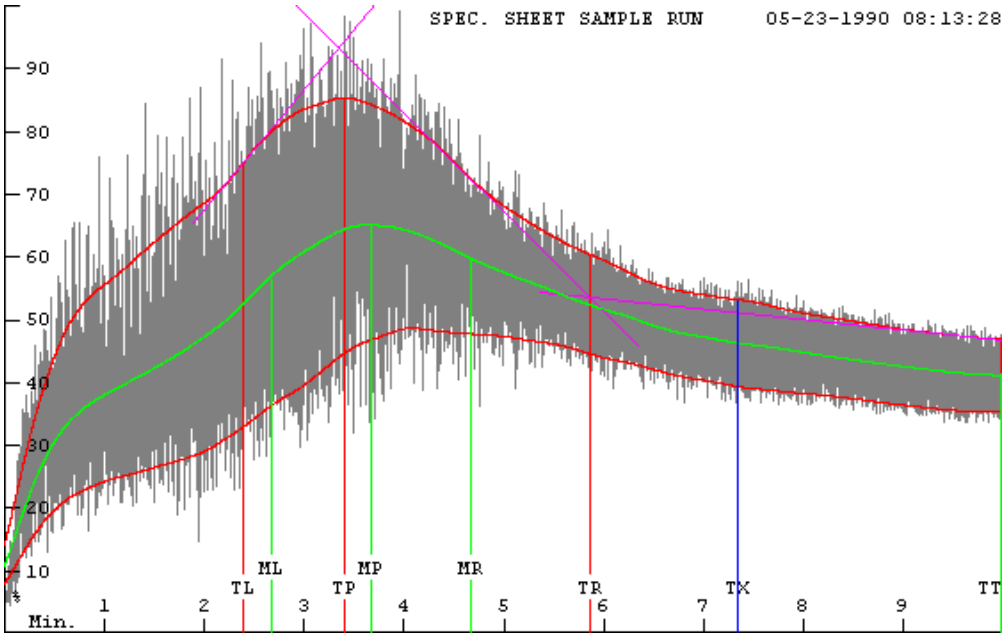
From this screen the user may toggle between the text and graphical report views using the 'Chg View' button or they may print the text report or the screen plot. Initially, the Windows default printer is selected as the printer destination, however, this can be changed for MixSmart under the Preferences→File Control and Routing menu. From this same menu the user can also select to automatically print the picture or report and choose whether and where to save the results.

While the example above is running in the normal or 'small-image' mode, it is possible to expand MixSmart to full screen size by clicking the 'Max' button on the program's title bar. This change cannot be performed while data collection or analysis is actually taking place. Analytical images (.BMP files) created with the screen in one mode will automatically rescale for viewing in the other mode. Be aware that .BMP images created when the form is maximized can be very large (3.5 megabytes on a 1280*1024*24bit desktop). For this reason, user's may not want to leave the 'Picture To File' option enabled for full screen work.

The data analysis itself is described later in this chapter and in greater detail in Chapter 13, 'Understanding and Controlling the Analysis'. The critical configuration and analysis control options are also described systematically in Chapter 10, 'The Defaults Variables Menus'.

Of course, the real value in this software is in collecting and analyzing the user's own data sets. This is described in Chapter 3, 'Installing the Analog Interface and Collecting Data'.

The next page contains a copy of the analysis of the included sample file. Normally the report and picture prints are a full page each, but they are reduced here for the sake of brevity. Please refer to this page during the brief discussion which follows.



SPEC. SHEET SAMPLE RUN

SAMPLE.MXG — Created: 05-23-1990 08:13:28
Profile: MIXSMART.INI — Analyzed: 12-14-2003 14:56:54

VARIABLE DESCRIPTION	VALUE	VARIABLE DESCRIPTION	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Pre-Analysis Filter	1.010	Pre-Analysis No. Stages	0
Mid Curve Filter	80.000	Mid Curve No. Stages	2
Delta Left of Peak (Min.)	1.00	Delta Right of Peak	1.00
TORQUE Min. Std. Reading	2096	TORQUE Max. Std. Reading	2699
Analysis Start Time (Min.)	0.00	Delta End Time	0.00
Top Finder Window (Sec.)	0.70	Bottom Finder Window (Sec.	0.70
Top Curve Filter	80.000	Top Curve No. Stages	2
Bottom Curve Filter	80.000	Bottom Curve No. Stages	2
Arbitrary Time 'X' (Min.)	mp*2	Envelope Slope Scanning Wi	5.00
Use Manual First Mid Peak	No	Mid Peak Fit Window (%)	5.00
Use Manual First Top Peak	No	Top Peak Fit Window (%)	5.00
Moisture (%)	14.00	Mixer Type	10g Fix
Protein (%)	13.00	Data Sampling Method	Sync.
Ash (%)	0.90	Main Shaft RPM	88.01
Absorption (%)	63.00	Sample Type	HRW
Operator Name	ALAN WA	Sample Alternate/Customer	

ENVELOPE ANALYSIS:	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min)
LEFT_OF_PEAK	2.39	75.020	19.099	42.034	74.031
PEAK	3.40	85.310	0.000	40.660	117.699
RIGHT_OF_PEAK	5.87	60.397	-15.793	15.857	182.185
CURVE_TAIL	10.00	46.782	-1.642	11.553	236.080
TIME_'X'	7.34	53.230	-2.348	13.858	202.960

MID LINE ANALYSIS:	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min)
LEFT_OF_PEAK	2.67	56.794	14.283	43.647	105.496
PEAK	3.67	65.107	0.000	37.449	167.601
RIGHT_OF_PEAK	4.67	59.855	-7.454	24.693	230.729
CURVE_TAIL	10.00	41.117	-0.972	11.553	485.293
TIME_'X'	7.34	46.332	-2.369	13.858	369.801

2.5 Interpreting the Report

Among the many numbers on this page, the time to peak (maximum mixing resistance) for both mid line and top of envelope are found, as are the % of full scale (value, %). These values (time to peak and peak height) are traditionally the most meaningful. A mid line peak time around 3 to 5 minutes, and about 60% of scale is usually about right for bread flours. (Note that each wheat breeder, miller and baker will have his or her own idea of "best" value.) Very steep left-of-peak and right-of-peak slopes are undesirable. This indicates a flour sample with low tolerance and a high sensitivity to mixing time.

By taking the sum of the absolute values for the left of peak and right of peak slopes for the envelope top line or mid line analyses a single number may be used as a measure of mixing stability or tolerance. A small value indicates a flat, stable, curve. A large value indicates a rapid rise and/or breakdown, which is usually undesirable.

Delayed peaks and narrow widths (especially at about 8 min.) are often taken as indicating "weakness". An extremely wide ascending portion, coupled with wild swings, indicates the absorption was too low (not enough water). On the other hand, a narrower, smoother, curve-- often with an early false peak-- followed by a sway back centerline, indicates too much water.

The 'integral' values for the midline section are for the areas beneath the mid line from time zero to the point in question. The units are the vertical axis (% torque) multiplied by the horizontal axis (minutes). These values represent the work put into the flour and water dough in order to develop it. The ‘integral’ values for the envelope section are the areas bounded by the upper and lower envelope curves from time zero to the point in question. Envelope integrals should not be directly interpreted as work applied.

In summary, the mid line time to peak and peak value, the area to that point, the top line ascending and descending slopes (or the sum of their absolute values) and the bandwidth at 8 minutes are the values most used, however, a great deal more information is available as the following brief description of this sample report will show.

The first few lines of the report provide the user supplied title and file name; the date and time the data was collected; and the date and time it was analyzed. This tracking information will become invaluable as your library of reports grows.

The next block is a table of some of the most significant analytical parameters. These parameters are important in the comparison of samples. Except for

slight variations due to wheat class (for example pastry versus bread) and interface re-calibration, these numbers should not be adjusted often.

Some of the data in this block will not necessarily represent the current settings of the defaults variables, but will instead represent their state at the time the data file was recorded. It is these circumstantial values that are most important during the re-analysis. The follow variables fall into this category:

Frequency,
Total Run Time,
TORQUE Min. Std. Reading,
TORQUE Max. Std. Reading

'Envelope Analysis' is the first analytical block. It includes the information gleaned from the upper and lower traces of the curve. The curve legend markings which begin with 'T' (for Top) refer to this part of the printout. The 'Envelope Analysis Specifics' option under the preferences menu, described in detail in Chapter 13, controls the behavior of this portion of the report.

The next block on the sample output form concerns the mid line analysis. The information contained here is the most consistent between sample replications and the least sensitive to changes in the analytical parameters. The values for work integral are, in particular, very consistent. The curve legend markings which begin with 'M' (for Middle) refer to this part of the printout. The 'Midline Analysis Specifics' option under the preferences menu mostly controls the results presented in this area. Detailed explanations of these numbers are also available in Chapter 13.

One other report block is available. The 'USER ANALYSIS' option which invokes custom .PGM modules, is suppressed by default. This advanced feature, controlled by the 'User's Analysis Control' option of the preferences menu, is explained in section 10.5 and Chapter 17.

There are certain obvious interactions between these sections. For example, the width at mid line peak is dependent on the envelope data. Certain other numbers are fixed by the variables and may not be affected by the data itself. The slope at either peak is by definition equal to zero (but may be slightly different as measured). The time value for Curve Tail is calculated from the 'TotalRunTime' less the 'DeltaEndTime'. Time_'X' is, in this case, a user chosen time. It may also be selected relative to the envelope or mid line peak times.

Chapter 3

Installing the Analog Interface and Collecting Data

3.1 Installing the ADCComm Interface

The computer interface designed for the Mixograph contains several connectors, which should be examined before installation is attempted.

Before turning on your computer, attach the power cord to the ADCComm interface, but leave the unit turned off. Also attach the instrument (Mixograph) to the Channel 0 analog input of the black box and attach the DB9 cable between the ADCComm's 'computer' connector and the PC's free DB9M serial port. If no DB9m serial port is available on your computer, a DB25M serial port connector can be adapted for use or an additional serial interface port can be installed. Call National Mfg. for assistance if this proves problematic.

After all cables have been attached, boot the computer and then turn on the ADCComm. The 'Power' indicator will signal a successful initialization by blinking three times and then remaining on. If this does not occur, shut down the interface, disconnect it from the computer, check the power connection, and try powering it up again. If the problem persists, call National for assistance

This combination signal conditioner and analog to digital converter unit allows the Mixograph and other instrumentation to be simply interfaced to an IBM compatible computer. The module is powered directly from the AC line by a modular power cord which can be supplied in a style compatible with the local standard. The power supply itself is of the universal input type and requires no user adjustment for different regions. The ADCComm draws very little power and may be left turned on, but we recommend shutting down the interface when the MixSmart system is not in use. A simple rocker switch by the power inlet serves this purpose.

Warning

Do not interrupt the power to this interface during use. Such an event will terminate data collection and could disrupt mixer operation if the mixer's power is under the control of the ADCComm.

A host connection is provided by the DB9 female connector, which is marked 'Computer'. A DB9 extension cable (supplied) joins this connector to an IBM compatible computer via its serial communications port. MixSmart For Windows supports this interface only. The new ADCComm unit cannot be used with the DOS version of MixSmart and likewise, the DOS compatible SGA/ADC-P2 interface cannot be used with MixSmart for Windows. The host PC must have an unused serial port (Com1:, Com2:, etc.). If it does not, an additional port can usually be added either through an interface card, or preferably as an external USB device. Be aware that USB devices are not available under Windows NT and are problematic in Windows 95.

The Analog side of the ADCComm is typically attached at the 'Input Channel 0' DB9 female connector to the Mixograph's moving bowl sensor harness. It is also possible to use the ADCComm interface on strain gauge sensors and

external analog signal sources like 'watt-meters', however, such applications will require some assistance and possibly additional parts from National Mfg. The ADCComm unit is designed to support up to 4 analog inputs (Channels 0 to 3), but only number zero is included with a standard MixSmart installation or retrofit.

Warning

Be very careful not to interchange the cabling between the ADCComm's Computer (serial port) connection and the Channel 0--3 (Analog Input) side. Doing so could damage the interface or the computer or both.

ADCComm also contains control circuits to turn a mixer on and off, to measure mixer RPM, and to sample synchronously with the Mixer head position. However, these features are not yet available on most of National's mixers. For those instruments which support them, a special wiring harness can be provided by National.

Users of the 2 gram Mixograph who wish to upgrade their software and interface will need to send the control unit in for a retrofit. Please call National for assistance.

3.2 Calibrating the ADCComm

Unlike the old SGA/ADC-P2, the ADCComm interface does not require physical calibration using trim-pots. These functions are handled in MixSmart For Windows using the automated 'Calibrate Hardware' function of the 'Calibrate Mixograph Torque Sensor' option under the Utilities menu.

Note

National Mfg. normally calibrates MixSmart/Mixograph kits before shipping them to the customer. These initial calibration values should have been pre-encoded on the cutomer's CD-ROM for all supplied user profiles. If supplied on paper, be sure to enter them in the appropriate fields on the calibration screen. In any case, the user should check calibration at setup, before attempting to update it.

The Calibration procedures described here will directly change settings in the active user profile (typically MixSmart.ini). When the defaults variable 'UseShared Calibrations' is set to 'True' (as it is by default), some of these changes may be shared with other profiles. Calibration sharing is explained in detail in section 10.6.

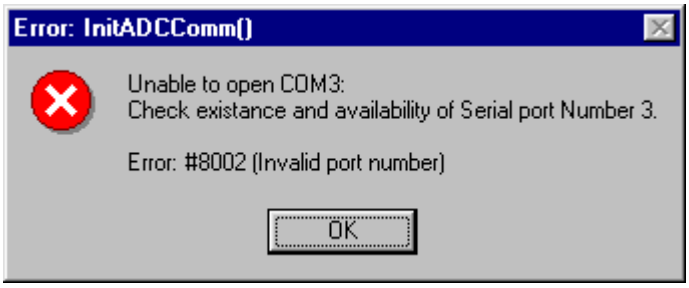
The remainder of this sub-chapter takes the user through the adjustments as they would be performed for all of the sensor options including moving bowl, direct drive, and strain gage.

Before calibrating or using the ADCComm, it may be necessary to select the serial communication port which will be used. In Windows these can be assigned any number from 1 to 16, but are typically 1, 2, 3, or 4. Set this critical value using the 'Data Collection and Interface Control' option under the preferences menu.

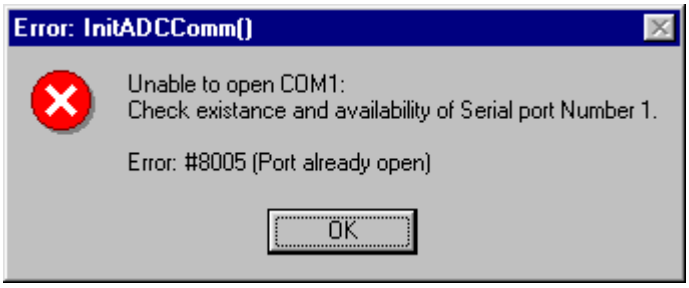
After setting the Communications port, begin MixSmart ADC calibration by Invoking the 'Calibrate Mixograph Torque Sensor' option available from the Mixograph Utilities Menu.

If the live calibration form does not appear, then an error message like one of the following should be displayed:

In the above case, the port exists on the machine, but appears to have no interface box attached to it. Verify that the ADCComm is definitely connected to this connector on the PC. Also verify that it powered up and generated a proper 'ready' signal on its indicators.

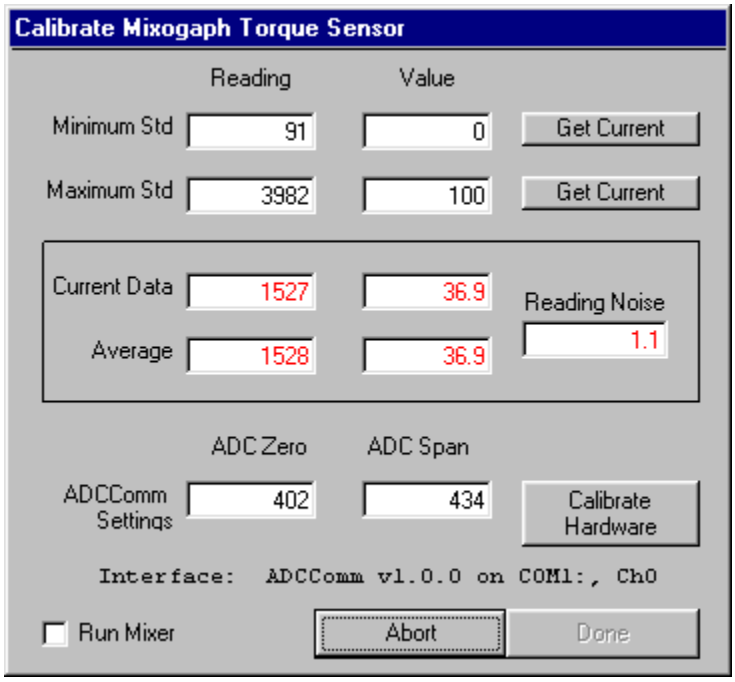


In this second case, a serial port number was chosen which is undefined on this computer. Choose an extant serial port.



In this last case, the serial port exists but is currently in use by another application. This other application may be controlling a modem on this port; or It may be a terminal program. You may also have accidentally launched another instance of MixSmart For Windows. Technically it is possible to run more than one copy at a time on a single PC, but two different user profiles must be selected and, if data will be collected, different communications ports must be used.

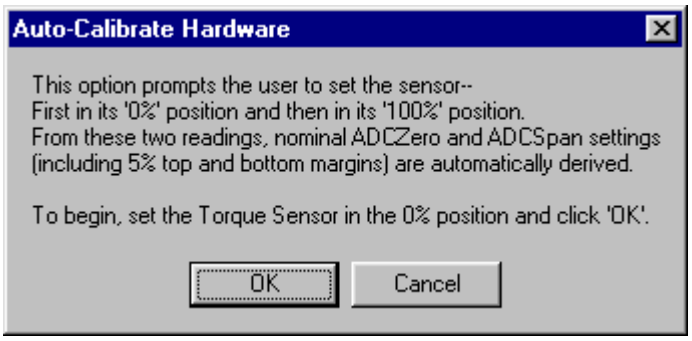
Once any errors (as above) have been resolved, the calibration screen appears:

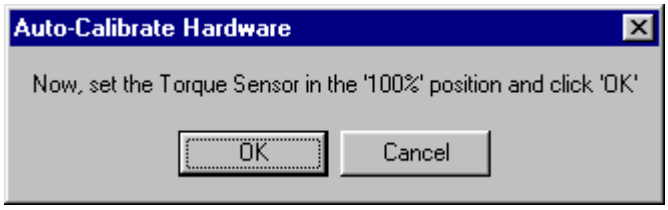


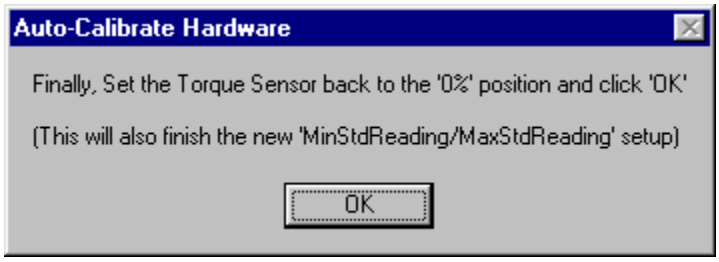
This is a live view of the ADCComm interface. The numbers inside the central box should update continuously. For purposes of initial test, move the Mixograph to its 0% position. If this produces a 'Value' entry on the 'Current Data' row of 0% then make the same test with the Mixer's arm set at the 100% position. If this returns a 'Value' of 100% then the unit is fully calibrated and ready for use.

If the sensor is not properly calibrated, the user may make small adjustments by typing new values in the 'Minimum Std' or 'Maximum Std' rows under the 'Reading' Column. More conveniently, the current average reading of the sensor can be transferred directly using the 'Get Current' buttons.

The simple calibration options described above will only work if the mixer returns a reading in the 25 to 250 range when at the zero position and it returns a 3850-4070 range reading when the at the 100% position. Readings outside of this range imply that a full 'hardware scaled' calibration is necessary. However, this is quite easily done by simply pressing the 'Calibrate Hardware' button and following the the self-explanatory prompts (reproduced here:







Pressing cancel on either of the first two screens returns to the Calibration screen without making any changes. Following the instructions and pressing 'OK' on each screen, will recalibrate the sensor and interface. Verify that the 'Value' reported on the center of this screen now varies appropriately between 0% and 100% and click on 'Done' to make the changes permanent.

Failing to follow the instructions carefully (for example not moving the sensor to its new position before clicking 'OK') will usually result in a meaningful error message, but it can also generate an illegal set of calibrations that return 'Error' in the value field. In this case, either abort the calibration screen entirely or run the hardware calibration again.

Once the Mixograph is put into regular service, the actual adjustments needed will probably be minor and infrequent, but the user is expected to understand and be able to perform them. At the very least, the correctness of the current settings should be verified at the time the system is set up, whenever it is moved, and on some regular schedule.

The actual readings you achieve for the 0% and 100% scale positions after calibration are not critical so long as they are properly recorded in the

maximum and minimum plot values variables. A zero of from 40 to 500 and a span (difference between largest and smallest) of 2500 points or more are acceptable. Larger ranges will provide slightly higher precision, but the difference is subtle.

Notes on Moving Bowl Calibration

For the moving bowl Mixograph, the 'zero position' is achieved by turning the bowl/pen assembly fully counter-clockwise to the no-load (0%) position.

For the 100% position, rotate the bowl/pen assembly fully clockwise to the 100% position and temporarily unhook the spring so that the bowl stays in this position

Notes on Direct Drive Calibration

For direct drive Mixographs (those like the 2 gram units which have no moving bowl) run the system under no-load conditions for the 0% setting required during calibration.

For the 100% setting set up the 100% physical calibration device. This might be a calibrated electronic clutch or a viscosity standard in the Mixograph bowl.

In the absence of a high standard reference, it is necessary to calibrate a direct drive Mixograph by comparing its results for a standard flour with those obtained by another, previously calibrated, Mixograph. (In order to use this method the user may need to look ahead to section 3.4, which explains how to record a full Mixograph run.)

Begin this procedure by setting the ADCZero to 0 and the ADC gain to 1023 (record the previous values in case they must be re-used later. Also set the direct drive unit's 'Torque Min. Std. Reading' to what ever the calibration utility reports as its no-load value. Set the 'Torque Max. Std. Reading' to 4095.

Next run an identical sample on both the direct drive unit and on a standard, previously calibrated, Mixograph. This work is more easily done using another computerized unit, but it's not strictly necessary.

Having run the sample on both machines, the two mid line peak values (in percent) and the direct drive's current Min. Std Reading and Max. Std. Reading are used in the following equation to derive a corrected 'Torque Max. Std Reading' which must be entered into the preferences.

$$MAX_{new} = MIN_{crnt} + (MAX_{crnt} - MIN_{crnt}) * MIDPEAK_{crnt} / MIDPEAK_{std}$$

The direct drive curve should then be re-analyzed with this new calibration value. Remember, in order to impose a new calibration on an existing data set

the range imbedded in the MXG file must be temporarily overridden by the batch file processor or permanently changed using the Date File Header editor on the Utilities Menu.

If the calibrated reading span (Max. – Min.) brought about by this translation is very small (less than 2500 points) the user should reduce the ADC Gain value by about 20%, re-tune the instruments Min. reading , and try this procedure again. Remember that the mid line peak value obtained from the previously calibrated moving bowl Mixograph is still valid.

If a proper calibration source is not available, the correct full-scale voltage span may be very crudely approximated by setting the ADC Gain control to about 900, the ADC Zero control to 0, the Max. Std. Reading to 4095, and then retuning the Min. Std Reading. Any data collected under these circumstances can be re-scaled later when a standard reference is established and in the meantime is perfectly valid when compared to subsequent runs on the same Mixograph.

Notes on Strain Gage Calibration

For strain gage interfaced Mixographs, the 'zero position' is achieved by measuring the instrument in the no-load (0%) position. For the 100% position, use a calibration spring or weights.

Mixer RPM

The utilities menu also allows measuring the Mixer's RPM and calibrating the head position for synchronous sampling. However, as these features are not available on most mixers and not necessary to acquire data by the traditional timer based methods, they will be discussed later (see section 9.4).

The defaults settings which can be adjusted by these interactive calibration screens are also accessible as simple data entries from the Data Collection and Interface Control option of the Preferences menu.

The 'Calibrate Mixograph Torque Sensor' screen also provides a rough metric of the analog signal quality as an 'ADC Noise' value. This value is calculated for each set of ten raw sensor readings (spanning one second) as the sum of the absolute differences between each of the ten readings and the mean of the same ten readings. In other Words:

X_i = a single sensor reading

$X_{mean} = (X_1+X_2 \ldots +X_{10})/10$

$\text{ADC Noise} = (|X_1-X_{mean}| + |X_2-X_{mean}| \ldots + |X_{10}-X_{mean}|) / 10$

For standard ADCComm installations on a moving bowl system, the ADC Noise value will be less than one. Obviously, this value is meaningless if the bowl is actually moving at the time of the observation. Strain gauge sensors can be somewhat noisier (typical noise values are 3—4) and adapted direct drive systems like the two gram have a very noisy baseline (typical noise values may be as high as 50). Remember, however, that most of this moment-to-moment chatter is effectively eliminated by the filtering and analysis methods used to generate the MixSmart reports.

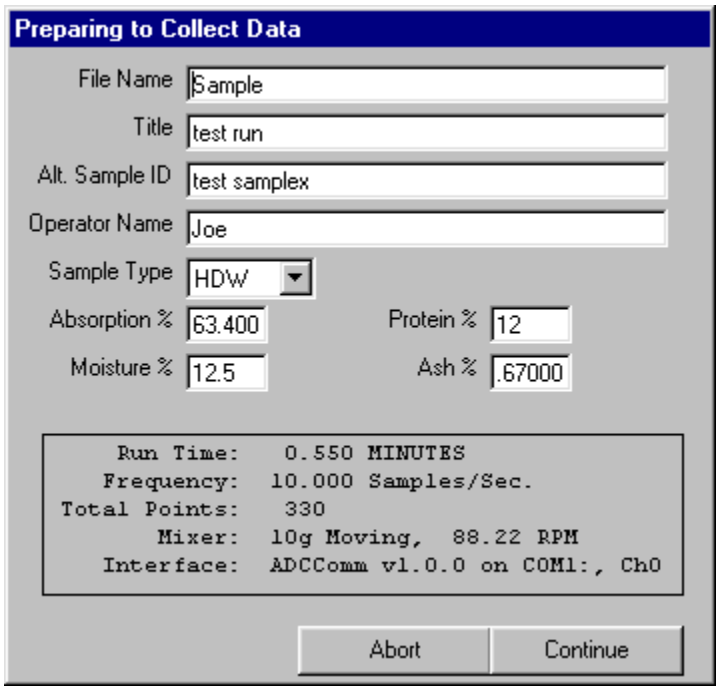
3.3 Collecting Data

This section assumes that you are familiar with and have installed the MixSmart for Windows program and have analyzed the sample run as described in parts 1 and 2. In order to actually collect data the interface must be installed and tested. This process was described in the previous section. The following list will take the user through the process of electronically acquiring a mixogram.

Launch MixSmart For Windows and choose a user profile. Also, power up the ADCComm chassis and verify the ready light.

The user will typically not need to adjust the total run time, sampling frequency, or calibration settings but these can be modified from the 'Data Collection and Interface Control Preferences menu.

Begin by choosing 'Collect & Analyze' from the Collect/Analyze menu. This will bring up the following screen:



Type in a new file name (long file names are allowed). Also enter a title and adjust any other fields to match the current sample. Note that the data in the outlined region may not be altered from this screen.

Before clicking 'Continue' to begin the run, place the flour-water sample in the Mixograph and prepare it for operation, except actually starting the motor.

At this point, choose ‘Continue’ to enter the ‘Pre-Trigger’ screen. The actual data collection is launched from this 'waiting room' when the appropriate trigger event occurs. This trigger event can be a change in the analog signal when it exceeds a preset threshold (Auto-trigger) or it can be the user clicking the ‘Start Now’ button. This pre-trigger screen has three lines of text in the center of it which provide information on the triggering method, whether the baseline will be zeroed, the current baseline, and a measurement of noise in the analog channel.

Warning

Entering the pre-trigger screen also turns on the Motor control signal in the ADCComm unit.

Mixers which are not directly controlled by the interface require that the user start the motor. In either case the ‘turbulence’ which this causes will start data collection if the Auto-trigger threshold is set to a reasonably small number (typically 5). if Auto-Trigger is set to zero, start the run manually by simultaneously turning on the mixer and clicking on the ‘Start Now button’.

After the specified run time, the collected data is saved to a ".MXG" file. It is also possible to force the data collection to terminate and save before the full runtime. This is accomplished by Clicking ‘Quit and Save’. To abort data collection, saving nothing choose ‘Abort’. Once the data file is saved, it is then reloaded and analyzed according to the defaults variables. By automatically saving the file first there is no risk of data loss if the analyzer should fail because of bad defaults choices. In rare cases, MixSmart may encounter a problem saving the data file-- the most likely causes being an invalid file path due to an open drive door, a write protected diskette, or a full disk. If this happens an explanatory error screen should appear, but the new data set is lost. Correct the cause of the problem, setup the Mixograph for a replicate run, and try again.

3.4 Mixograph Computerization Methods

The remainder of this chapter provides a discussion of the various computerization methods used in the past to collect data from a Mixograph. The user may skip this note if they wish.

There are at least three distinctly different methods used to record the mixing torque changes which occur as a dough develops. It is interesting to note that Drs. Swanson and Working were aware of and tried all three, before settling on the system used on present day mechanical recording Mixographs. It was the only satisfactory method, given the technology available in the 1930's.

Moving Bowl Method
The Mixograph bowl is normally permitted to rotate about a central axis, limited to an arc of about 38º to prevent the bowl and planetary head pins from clashing. Torque transmitted from the head through the dough to the bowl causes it to rotate against the restraining spring. The violent oscillations caused as the head pins alternately hurdle and straddle the bowl pins are dampened by a string driven spindle or by an inertial mass at the end of the bowl base extension arm. A pen records these oscillations as a simple strip chart in the conventional design.

A position sensor may be attached in such a way as to reflect this rotary motion. For example, a simple linear potentiometer may be attached to the bowl base's ball-bearing shaft. More sophisticated designs based upon optical encoding devices or by sensing differences in electrical properties (capacitance or inductance) may also be used, but the principle remains the same. In some way, a variable voltage signal is produced, the value being a function of bowl position. Current moving-bowl Mixographs use a non-contacting rotary Hall-effect sensor built into the bowl bearing assembly

This approach has the advantage that the resulting signal trace looks almost identical to a conventional mixogram, and can be analyzed by computer. Calibration is easily done by relating the minimum and maximum scaling values directly to pen position. The signal conditioning electronics are typically simple, but the transducer requires some construction and user installation skills. This approach also retains most disadvantages of the mechanical system. It is still dependent upon spring and damper variations, subject to bearing wear or failure, and still requires the same size case and bench space.

Fixed Bowl Method
The bowl may be nearly restrained from swinging by some type of force transducer which limits the rotation to a fraction of a degree. For example, a load cell incorporating a strain gauge may be attached to the bowl platform. Any attempts to turn the bowl are transmitted as a variable voltage signal. The

small signal (millivolts) may be recorded directly by an electronic strip chart recorder, or it may be amplified and converted to digital values by any of several commercial or custom built analog to digital converters (ADC's).

This method has the advantage that the spring, damper, long arm, etc. are all eliminated. Also, as the base remains nearly stationary, uniform clearance between the head pins and the bowl pins is guaranteed for both strong and weak doughs. One may also read points above the nominal 100% torque load. This is not possible in the moving bowl system which has mechanical stops. Calibration is more complicated than in the preceding approach, but can be done with a simple and inexpensive weight and pulley set. The electronics required are somewhat more complicated and more sensitive to noise.

Direct Drive Method

Rather than measuring transmitted torque, as above, it is possible to directly read the electrical power drawn by the motor which drives the mixer head pins. The advantages are that the signal is inherently electrical and does not require an external transducer, and the Mixograph itself is made much simpler by eliminating the bowl bearings and stops.

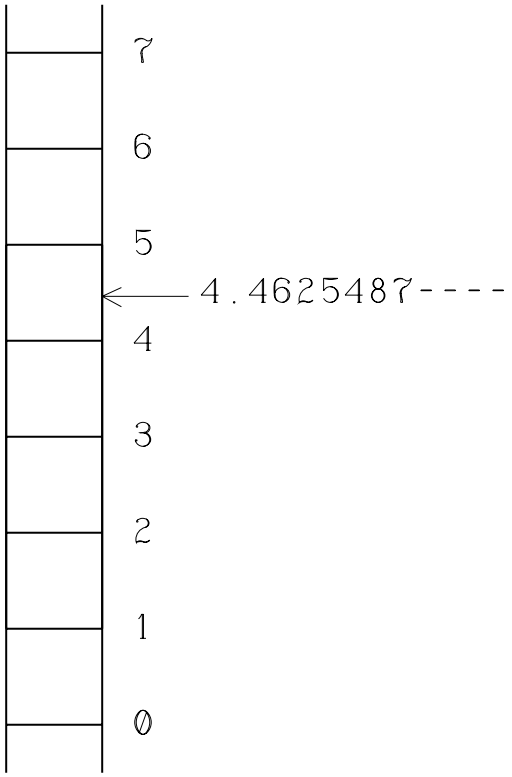
The preferred design uses a direct drive motor and gear train to avoid the frictional losses found in the conventional V-belt drive. The motor must operate at a constant speed, however, and not be substantially overpowered. The disadvantages are mostly calibration concerns: a (possibly) high and fluctuating no-load current draw, and the lack of a defined '100%' load. The electronics (power supply, motor control and load signal conditioning) are also considerably more complicated than for the first two methods and motor noise is a bigger problem.

Analog To Digital Conversion

Nearly all computers work with digital or quantized information rather than with the continuously variable or analog type. Most real world phenomena are of the analog type and thus require conversion to the digital domain before a computer may interpret them. An ADC (analog to digital converter) is the general name for a device which performs this translation. This module may be built into the instrument itself; it may be a separate, stand alone, 'black box' between the instrument and computer; or it may be a card mounted inside the computer.

While the actual operation is fairly complicated, integrated circuits are now available which do conversions from analog to digital values. The principal is easy to understand. Imagine a 7-foot long ladder with 8 rungs, enclosing 7 square spaces. The top rung may have a value of 7 and the bottom rung is 0. Any point along the ladder might have some analog value, e.g. 4.4625487----,

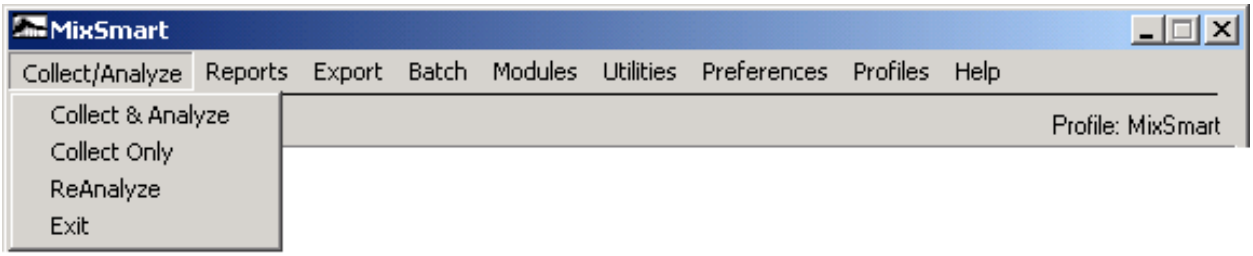
which falls between the rung numbered 4 and the one numbered 5. For purposes of 'digitizing', it might be given the integer value '4'.



A commercial ADC works in a similar fashion. The impressed voltage might vary any place from 0.00000 to 5.00000 volts, with the range broken into several hundred or even thousands of discrete steps, each assigned sequentially to an integer (whole number) value. For example, an '8 bit' converter has 256 steps numbered from 0 to 255, a '10 bit' converter has 1024 steps numbered from 0 to 1023, and a '12 bit' converter has 4096 steps numbered from 0 to 4095. The voltage signal impressed across the A/D input is matched to one of these discrete, sequential, uniformly sized steps. This 'index' number can then be read by the computer and manipulated by commercial general-purpose software or custom written programs such as MixSmart.

Chapter 4

Collect/Analyze Menu



This will be the menu used most by the MixSmart operator.

Collect & Analyze, already explained in chapter 3, allows the user to prepare and acquire a Mixograph data set which is saved as a .MXG file in the 'Data File Path' folder (selected from the File Control and Routing option of the Preferences menu). After collection, data analysis and report generation proceeds automatically.

Collect Only works as above, except that the analysis is not performed at the time the data is collected. Older versions of MixSmart, running on much slower computers, could take more than a minute to perform the standard analyses and even longer to print them. For this reason, the collection and analysis tasks were often performed separately. If the user should still wish to collect data without automatically analyzing it, this option is still appropriate and the next option can be used to perform the deferred analysis.

Reanalyze is most often used to re-process a single MixSmart data set after making some adjustment to the analytical settings via the preferences menu. If many datasets are to be reanalyzed, it is often easier to set up a batch file as explained in Chapter 7. This option must also be used to obtain the first analysis of a collected data set if it was captured using 'Collect Only'.

Exit closes MixSmart and returns the user to the Windows Desktop. Note that the 'X' button in the upper right corner of the Main screen will also do this. The loaded defaults profile will be saved to disk before shut down-- if it was changed during the session.

As a general note, the menus and the 'X' button area are not functional when a reanalysis, data collection, batch file, or .PGM module are running. In most cases some method of exiting the active task is instead provided (an 'Abort' button, for example). The user is encouraged to wait until control returns to the menus in the course of normal operation.

The Minimize button, '-', is available during data collection and can be used to shunt a running data acquisition out of the way without disrupting the operation. Be aware, however, that other foreground tasks (like word processing, spreadsheets, and scientific analysis) can eat up considerable resources and could conceivably cause data loss during acquisition. Faster computers, running the newer operating systems are strongly recommended if multitasking of this sort must occur during data collection.

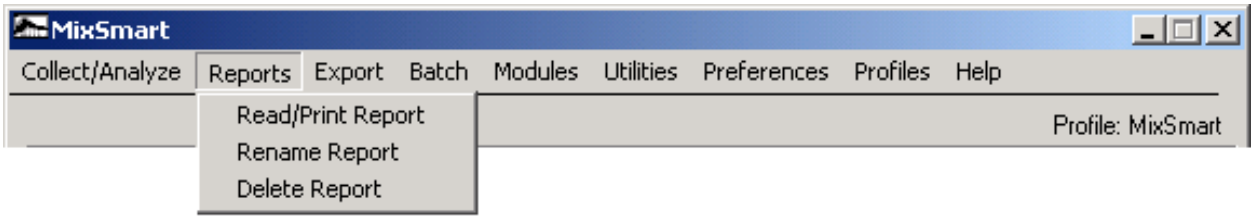
The other button in the title bar's control box, 'Maximize' can be used to shift MixSmart between normal (small screen) mode and full screen mode. This transition is not allowed while the data collection screen is active or during the actual reanalysis. Also, saving the analytical images (using 'Picture To file') in full screen mode creates substantially larger files so care must be taken not exhaust disk space.

Finally, because MixSmart now runs fully under Windows and the ADCComm unit interfaces via a standard buffered serial port, it is possible to run more than one instance of the software at a time by launching 'MixSmart For Windows' twice (or more) from the same desktop. This theoretically allows collection from two different Mixographs simultaneously, however, two ADCComm interfaces and two serial ports would be required. Also, very importantly, two separate profiles (.INI files) would be needed. Using the same profile in two different instances of MixSmart For Windows could result in loss of configuration settings.

While in practice it may work quite well, it is not recommended that the user collect data from one instance of MixSmart while running analyses and reports from another. As discussed above, data loss could occur during data acquisition.

Chapter 5

Reports Menu



This menu will be used most often for the review and printing of existing reports.

Read/Print Report presents a list of the report (.RPT) files stored in the current Report Files Path as set from the 'File Control and Routing' option of the Preferences menu. Once a report is selected, the text is reloaded to the on-screen browser for review. If an accompanying image file (.BMP) of the analysis was also found in the same directory, it will be loaded as well. The user may switch between these two displays using the 'Chg View' button. Buttons are also provided to print the report text or the image.

This option does not perform any analysis. It can only be used to display work already done. If a new report, reflecting a changed set of analytical parameters or a new data acquisition is needed, then use the Collect/Analyze menu.

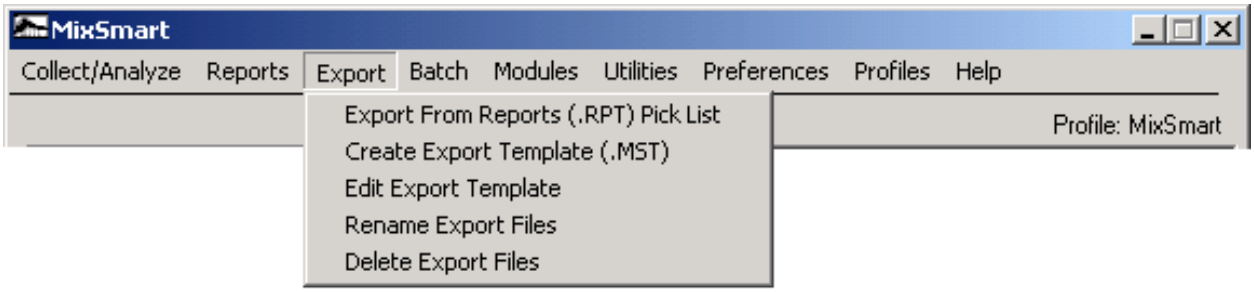
It is possible to shift between normal (small screen) mode and full screen mode before or while viewing these reports. In full screen mode, the text box elongates but retains its default width. The .BMP file (if it exists) rescales to fit the available screen. This works quite well if the image was recorded at a lower resolution, but some degradation will occur if a higher resolution image must be scaled down to 'normal' mode. The image will always print cleanly, however, no matter how it is displayed.

Rename Report allows renaming an existing report file and its image file (if present). The new file name can not already exist in the spreadsheets directory.

Delete Report allows deleting one or more Report files and their associated image files (if present) using standard windows 'multi-pick' methods.

Chapter 6

Export Menu



The text output from MixSmart is reasonably well laid out for human interpretation of the data, but it is not very efficient for feeding it back into other computer programs like spreadsheets. Also, the great volume of information generated can make re-keying the data impractical. The Export Menu allows the user to combine many reports into a single spreadsheet file accessible to other analytical tools like Excel, Lotus 123, and Quattro Pro.

The destination folder for spreadsheets is selected or created using the File Control and Routing option of the Preferences Menu. This same screen is used to assign the export extension (like .XLS) which is used when writing a file.

Export From Reports (.RPT) Pick List allows the user to select multiple report files to convert to a spreadsheet using a standard multi-pick .RPT file directory listing and an existing summary template (.MST) file. The user is also prompted to enter up to two comment lines which will be placed near the top of the resulting file. If the first comment entry is skipped by choosing 'Cancel' at the prompt, then the second one is also skipped. If a selected report file is damaged or not found, it is ignored during processing.

Create Export Template (.MST) creates an empty (untagged) template file to use for selecting report fields to export. One example template, SAMPLE.MST, is included with the distribution diskette and others can be set up quickly.

Edit Export Template presents a check list to add or remove report fields from a template file, controlling what elements are to be exported. Some example screens from this editor are shown at the end of this chapter.

Rename Export Files allows renaming export files (one at a time) in the 'spreadsheets' folder. Note that only files matching the currently selected export extension will show up in this list. The new file name can not already exist in the spreadsheets directory.

Delete Export Files allows deleting one or more export files in the spreadsheets folder using standard windows 'tagging' methods. Note that only files matching the currently selected export extension will show up in this list.

The following example is the (very) small spreadsheet which results from running a summary on the single report generated by SAMPLE.MXG and using the SAMPLE.MST template:

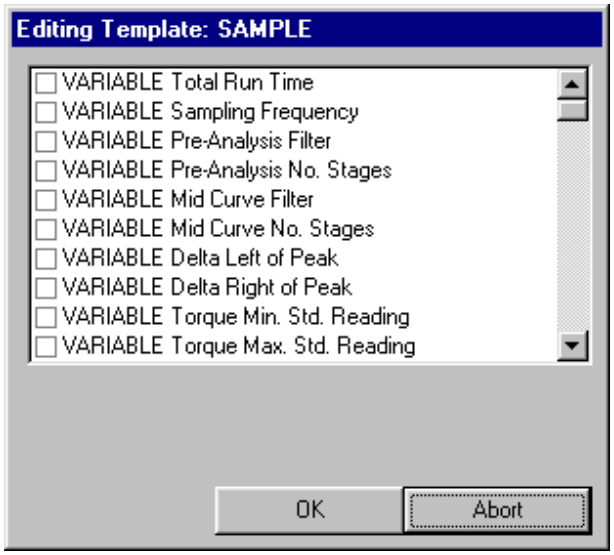
MixSmart Summary Report Created: 12-15-2003

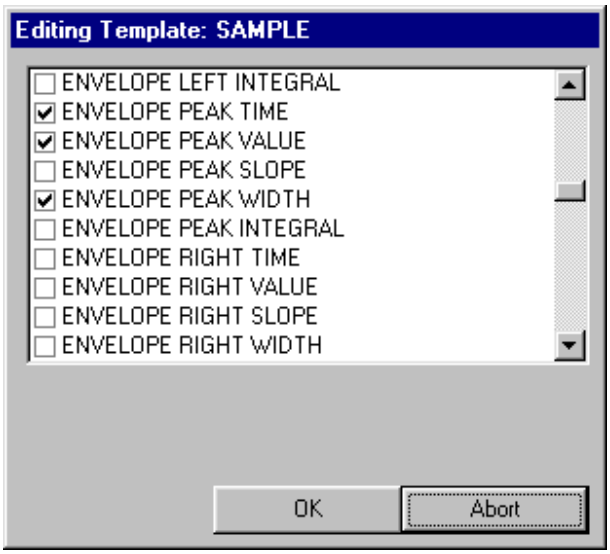
Comment: THIS IS A TEST USING SAMPLE.MST
RUN OVER THE SINGLE REPORT FILE SAMPLE.RPT (FROM SAMPLE.MXG)

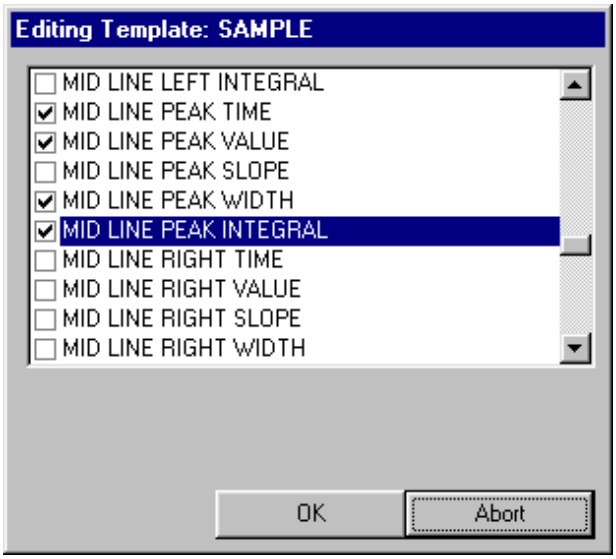
REPORT FILE	ENVELOPE PEAK TIME MINUTES	ENVELOPE PEAK VALUE %	ENVELOPE PEAK WIDTH %	MID LINE PEAK TIME MINUTES	MID LINE PEAK VALUE %	MID LINE PEAK WIDTH %	MID LINE PEAK INTEGRAL %TQ*MIN.
SAMPLE	3.40	85.310	40.660	3.67	65.107	37.449	167.601

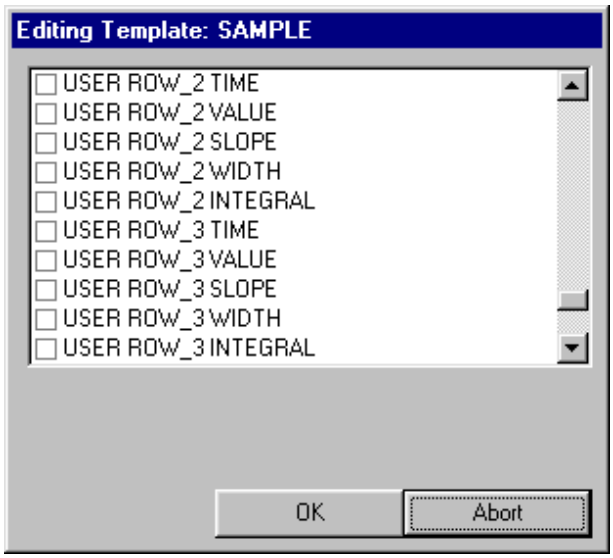
Some users may be saving report files with the option 'Append to Report File' selected. This means that each time a mixogram is analyzed, the results do not create a new .RPT file, but merely add to an existing one. At about 2500 characters per report, this can build up quickly, but the summary system handles it neatly by giving each 'page' within the report file its own line in the spreadsheet.

The following four screens show representative portions of the Export Template Editor which allows specific report results to be selected for transfer to a spreadsheet file. Choose 'OK' to save the changes or 'Abort' to discard them:





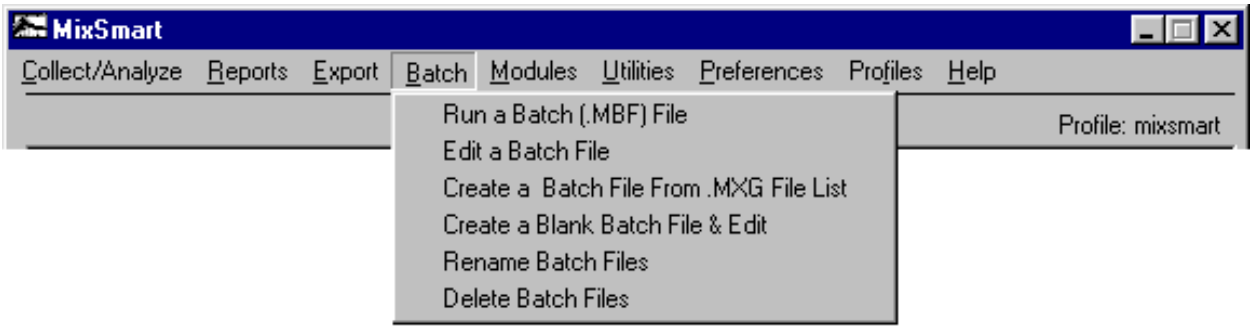




Users of earlier versions of MixSmart may note three changes to these pick lists. First, the variables section is now accessible to the spreadsheet exporter. These critical defaults values can now be used in subsequent, non-MixSmart based analyses. Second, the Envelope and Midline peak slopes can now be selected by the template. Theoretically always zero (and forced to that value in earlier versions of MixSmart), these fields are made available here for consistancy's sake. Finally, report data generated by user defined 'PGM' modules can be accessed in generic fashion, allowing export to a spreadsheet file.

Chapter 7

Batch Menu



Over the course of developing this software, it became apparent that some method of re-running large numbers of analyses without operator intervention would be very handy. The logical solution was to build a batch file processor into the software.

Note

The typical MixSmart user will find that the third option on this menu (Create Batch File…), followed by the first option (Run a Batch…) will cover all of their needs.

With MixSmart For Windows the batch processor has been made much more powerful by turning it into an extension of the .PGM module interpreter. MixSmart Batch Files (.MBF) can now contain any mix of .PGM supported commands including those for .MXG file loading and Analysis. A small section ([BATCH]) has been added to the STDINCL.PGM module to simplify these new methods.

Run a Batch (.MBF) File actually processes the text files created here, producing, potentially, a series of new data analyses or configuration changes to MixSmart. This is described in some detail later in this chapter.

MixSmart can not be resized (i.e. shifted between normal and full screen modes) while a batch file is running, but it can be minimized and restored during the run.

Edit a Batch File allows the user to modify or print an existing .MBF file

Create a Batch File from .MXG file List requires the user to key a name for the new batch file. As in all MixSmart file name handling, the drive letter, path, or extension should not be typed. The program composes the full batch file path name from the MixSmart main program path (typically 'C:\MixSmart

For Windows') and the batch file extension, '.MBF'. If this composite name already exists, the user is given the option of entering a different name or over-writing the old file.

In order to further automate the process of creating the list of Mixograph file names, this menu choice presents a windows 'Pick List' option to allow tagging from the current list of .MXG data files. The tagged file names are then written to the new .MBF file in proper format, with some surrounding boiler-plate and comments. See section 7.1 for a discussion of this structure.

Once created, the .MBF file is presented for editing so that the user may add additional comments or options. After this, the file may be executed using 'Run a Batch File' or from the command line (see Section 7.3).

Create a Blank MixSmart Batch File & Edit is used to build a simple batch file without any data sets. This provides the user with a all the standard structure, but allows manual entry of filenames and custom code.

Rename Batch Files allows renaming an existing MixSmart batch file. The new file name can not already exist in the MixSmart main directory.

Delete Batch Files allows deleting one or more batch files using standard windows 'multi-pick' methods.

7.1 The Mixograph Batch File Internal Syntax

The MixSmart batch file system has been greatly enhanced starting in DOS version 4.00 and further improved in MixSmart For Windows. These additions provide full support for the .PGM interpreter and allow defaults variables changes to persist between analysis runs. The following example was generated using 'Create Batch File From Reports file List':

```
1     ; ********** simplebatch.MBF **********
2     ;            File Created 12-19-2003     10:19:45
3     ;            By MIXSMART v1.0.372
4     ;
5     [BATCH]
6     clearstack
7     "batch" "stdincl" include
8     SaveVars
9
10    "SAMPLE" run
11    "SAMPLE2" run
12
13    RestoreVars
14    alldone
15    ; ********** simplebatch.MBF Ends **********
```

Not that the line numbers in front of this listing are for illumination only and are never present in the file itself.

Line numbers 1—4, 9,12, and 15 are blank or comments and thus ignored.

Line 5 identifies the lines which follow as the main executable subsection of the file. This is a piece of boilerplate which must always be present. Just as in .PGM files, multiple code sections can be included in this file. However, for the .MBF files only the section called '[BATCH]' can be executed. Any support files needed for a batch run should be loaded from standard .PGM files using the 'include' command in the batch file.

Line 6, clearstack, is recommended at the start of any batch file. Another similar command, ClearDict, can be problematic in batch files and general .PGM modules as it removes any previous user defined procedures. In particular, 'ClearDict' should not be invoked in any .PGM module which will be called (even indirectly) as part of a standard batch file as it will erase all of the add-ins loaded from the STCINCL.PGM file (discussed next).

Line 7 loads the standard batch file support library from its subsection of the STDINCL.PGM module. This module defines several addin modules which making automating re-analyses much easier. These add-ins include:

load	Allocates storage and loads a MXG file from disk

analyzetrap	Analyzes a loaded data set including (if enabled) a user's PGM module
run	Combines 'load' and 'analyzetrap' to simplify things
alldone	reports a successful finish to a batch file

Lines 8 and 13, SaveVars and RestoreVars, are used to preserve user preferences which may be altered during a batch file run. These operations cannot be nested. A second 'SaveVars' without an intervening 'RestoreVars' discards the first variables backup. This also applies if these functions appear in a user .PGM module.

Lines 10 and 11 (... run) are the meat of a MixSmart batch file. From these lines the actual data sets are loaded and re-analyzed. Users wishing to modify attributes which are part of a data set (for example the calibration settings), must replace the simple 'run' expression with a pair of commands. These load and analyze the file as separate events, allowing data manipulation in between. In the following fragment, the data file 'sample' has its title modified before analysis so that the new string 'Standard Run' will appear on the report instead of whatever title may have been originally save with the file.

```
"sample" load
"Standard Run" "mxg.title" writevar
analyzetrap
```

These changes are not persistent. The next time a data file is loaded, its own values for such a field are also loaded.

By way of comparison, the following example modifies a filter value and disables envelope analysis permanently unless the original value is restored either explicitly by the user or via 'RestoreVars':

```
320 "midfilter" writevar
false "enableenvelopeanalysis"  writevar
"sample" run
```

File path variables can also be changed in the same manner to allow much greater versatility in loading .mxg files and saving reports.

Line 14, 'alldone', generates a simple windows message box to inform the user that the batch file has completed its entire script.

Data and report file paths are may be changed using the writevar function defined in Chapter 15.

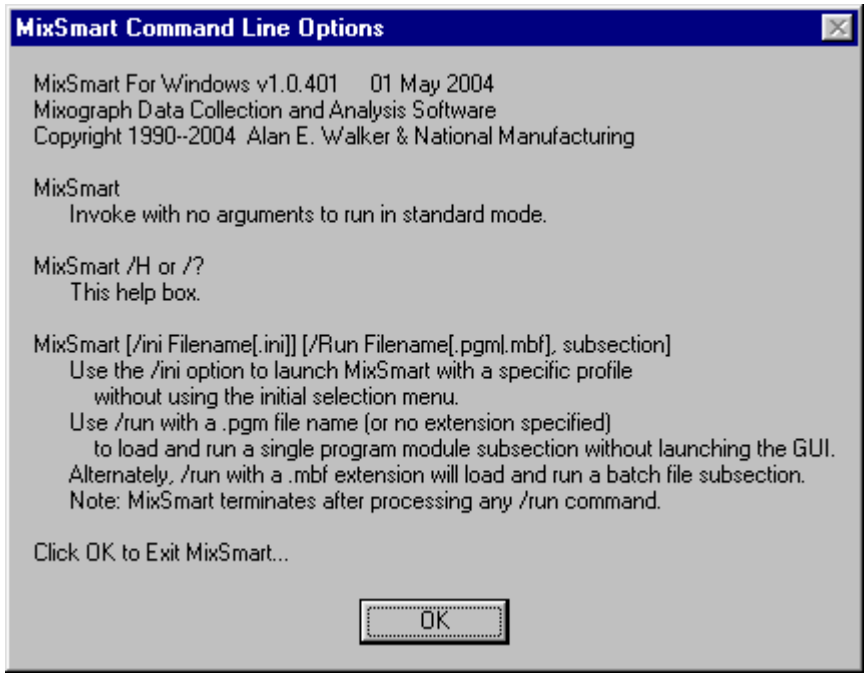
7.2 Pausing and Error Handling In a Batch File

It is generally not possible to interrupt a batch file itself while it is running. However, each data file as it is loading presents an 'Abort' button on the progress window. Pressing this button will cancel the current analysis and terminate the batch file. If an actual error is encountered while running a batch file, an error message will be generated and the run will terminate. If known, the error screen will specify the location of the problem in the batch file. Remember, of course, that it is possible the problem was not caused by the batch file but only showed up there. Good examples of this would be a printer set off-line or out of paper or a nonexistent (misspelled) file path or name. In many cases the error will actually display as a full debug dump of the underlying .PGM code, but the root cause can usually be determined by viewing the actual error message.

If an .MBF does terminate prematurely, the state of any modified defaults variables is indeterminate as the program will not have run the final '/RESTOREVARS' command which is typically at the end of the file. In this case, it may be easier to reload the current defaults profile from disk rather than try to correct any dangling changes.

7.3 Using the Command Line to Launch a Batch File

It is possible to run a .MBF file directly from the command line of MixSmart, or from the target field of the startup shortcut, it desired. Already discussed briefly in Chapter 2, the command line help screen is displayed again, here.



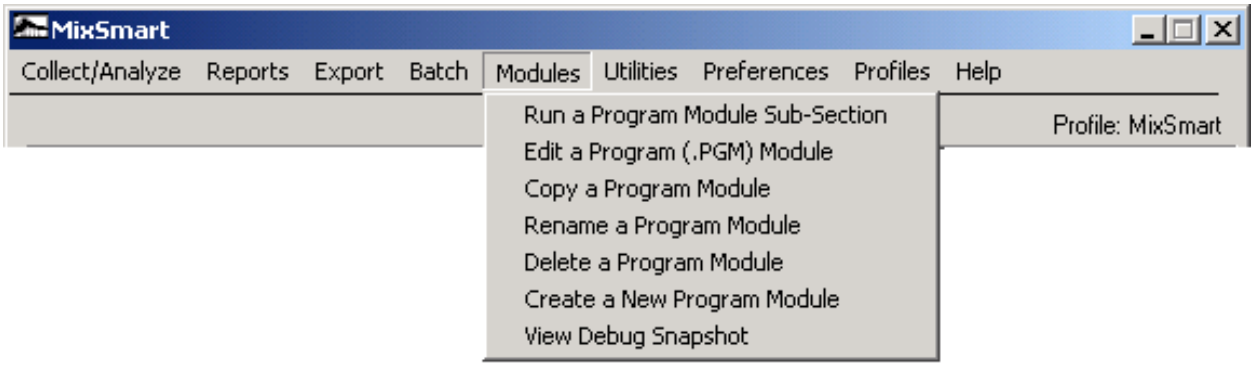
The /RUN option is very sophisticated and allows the user to load and invoke a .PGM (Program Module) file block or a .MBF (MixSmart Batch File) file block directly from the command line without running through all the menus. If the /INI option is not also present, the user will be prompted to choose a profile, but otherwise no main program interaction is required. MixSmart exits after the invoked file completes its run.

Note

Any changes to the user profile during a command line /RUN event are NOT saved before MixSmart exits.

Chapter 8

Modules Menu



Users wishing to develop their own custom analytical modules using the .PGM interpreter will find this menu indispensible. Details of the programming language itself, including a dictionary of functions and syntax and a set of example .PGM files can be found in Chapters 17 and 18.

Note

It is not necessary to understand or use any of the programmable elements of MixSmart in order to get very good use from the program.

Run a Program Module Sub-Section allows the developer to run a program to test operation. While this can certainly be done as part of the 'User Analysis' section of a MixSmart analysis, it is sometimes desirable to run a single sub-module quickly and without the overhead of a full MixSmart report generation. This option allows the user to select a .PGM file and a sub-section within it. This section is immediately run by the interpreter. The user must ensure the appropriateness of running a single .PGM subsection without the support of the implicit graphics mode and available .MXG temporary variables normally present during a full MixSmart analysis.

.PGM generated changes to the defaults variables (definitions, formats, and contents) persist between invocations of the interpreter as do dictionary entries like procedure definitions. In order to avoid resource exhaustion, blocks of code discarded when a dictionary name is re-used are periodically purged. This can also be done under user control via the interpreter's 'packmem' command.

MixSmart cannot be shifted between normal (small screen) mode and full screen mode while a .PGM file is running, but it can be minimized and restored.

Edit a Program (.PGM) Module allows the user to load, edit, print, and save a .PGM source file. These files are simple text documents stored in the 'Programs' directory of the the MixSmart For Windows main folder.

The imbedded text editor is the same used for editing batch files and viewing reports. The user is encouraged to limit row length to about 78 characters. However, the window will scroll horizontally as needed.

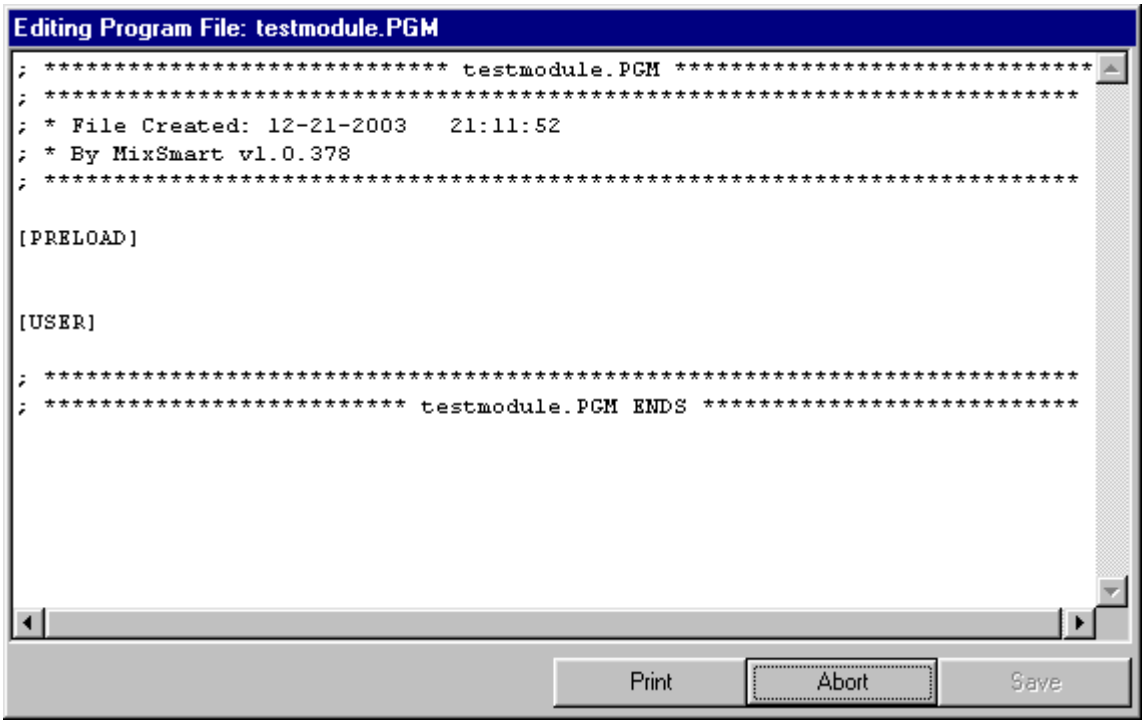
Alterations to the [USER] section of the currently active .PGM file (as indicated in the 'User Analysis' section of the Preferences menu) will take effect the next time a data set is analyzed. Changes to the [PRELOAD] section (for example, a menu edit) will not take effect until that section is reloaded by MixSmart. This happens when MixSmart starts, when a .PGM file is selected in the 'User Analysis' section, or (most conveniently) when the 'Enable User Analysis' box is unchecked and then checked again.

Copy a Program Module creates a new .PGM module by copying an existing file. The user will be prompted to enter a name for the new file. If the file already exists, the user may overwrite it (destroying the previous one) or they may enter another name. After creating a new module (either here or as a blank form), the new file is reloaded and presented for editing. Since, at that moment the on-screen version is identical to its just created disk version, the 'Save' button will be greyed-out. After making any changes to the file, the user will be able to save it.

Rename a Program Module allows a .PGM module to be renamed. If the newly chosen name already exists, the user must either try another name or abort the process by clicking 'Cancel'.

Delete a Program Module allows users to mark one or more .PGM files and delete them. Files erased by MixSmart are not buffered to the recycle bin, but are permanently removed.

Create a New Program Module allows the user to create a completely new .PGM file. After entering a new file name (which is checked for duplication), the user is presented with the following editor screen:



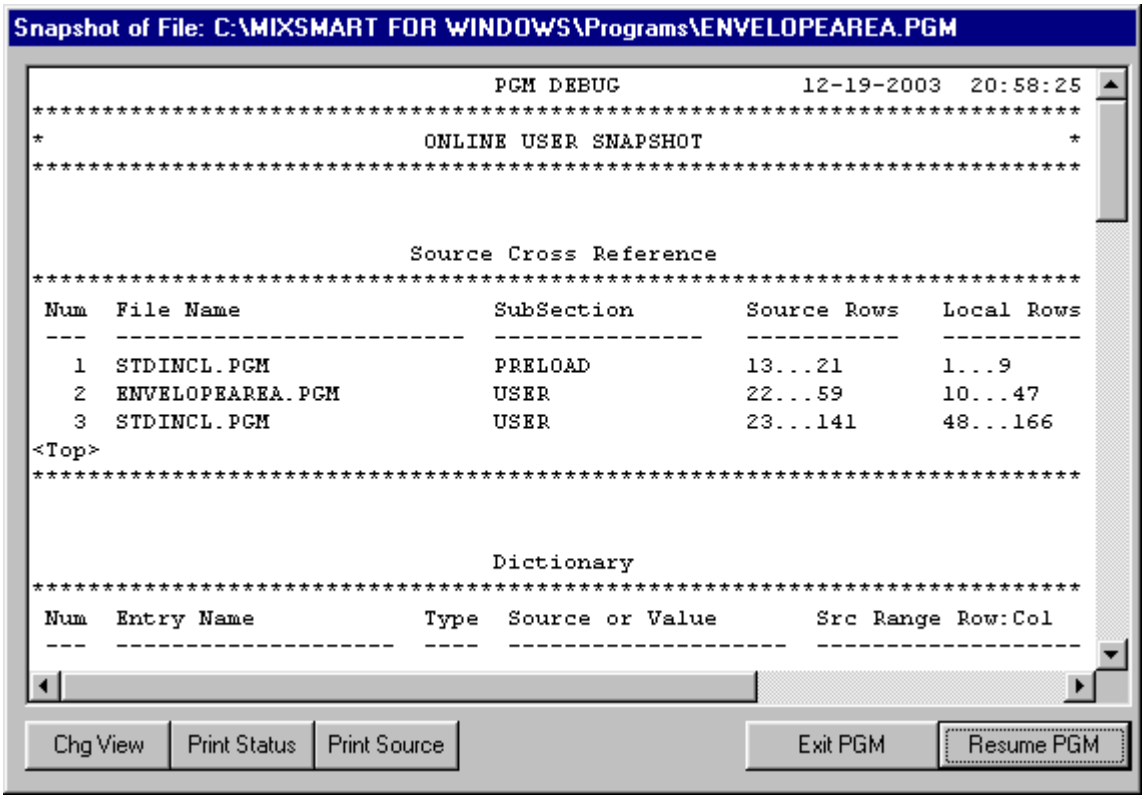
Users may create their custom analysis module from here. Note that the standard two sub-sections are already defined. The [PRELOAD] section is automatically processed when MixSmart launches or changes profiles (if the user analysis is enabled). This section is mostly used to establish custom defaults variables for the user's analysis. The [USER] section is run during each analysis, after the midline and envelope sections are finished (if they are used).

Note that this example is only a skeleton with no functionality, but still contains several comment lines. As with any programming project, frequent and meaningful comments are strongly encouraged in the development of MixSmart .PGM modules.

Note

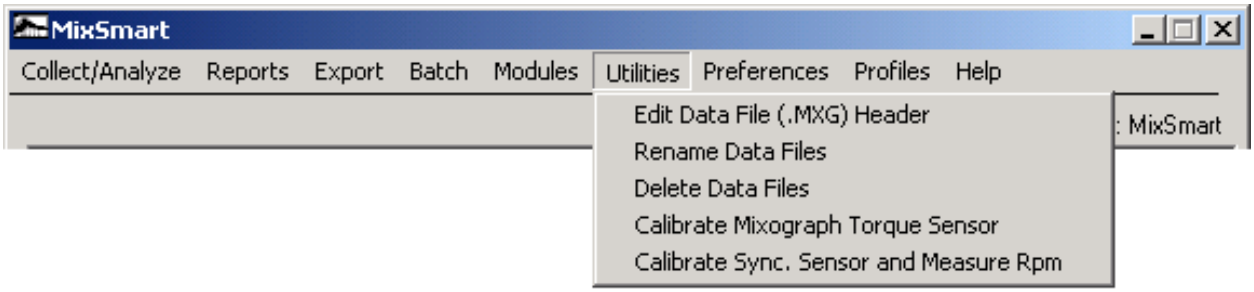
While the MixSmart .PGM extensions were designed to benefit end users, non-programmers may find the development process more complex than they care to tackle. For this reason, National Manufacturing can provide custom modules based on a user's written specifications. The cost for such work would depend on the complexity of the task. Please contact National concerning this service.

View Debug Snapshot is used to view or make a printout of the the current data stack, execution stack, dictionary, and active source module. Usually used as a post-mortem tool during debugging, this functionality is also available non-destructively within a running .PGM module via the 'debug' command. An example screen of the 'status view' is presented here. The other half of the debug report, accessed via the 'Chg View' button, is the active module's source listing-- including line numbers and a marker to indicate the current interpreter position.



Chapter 9

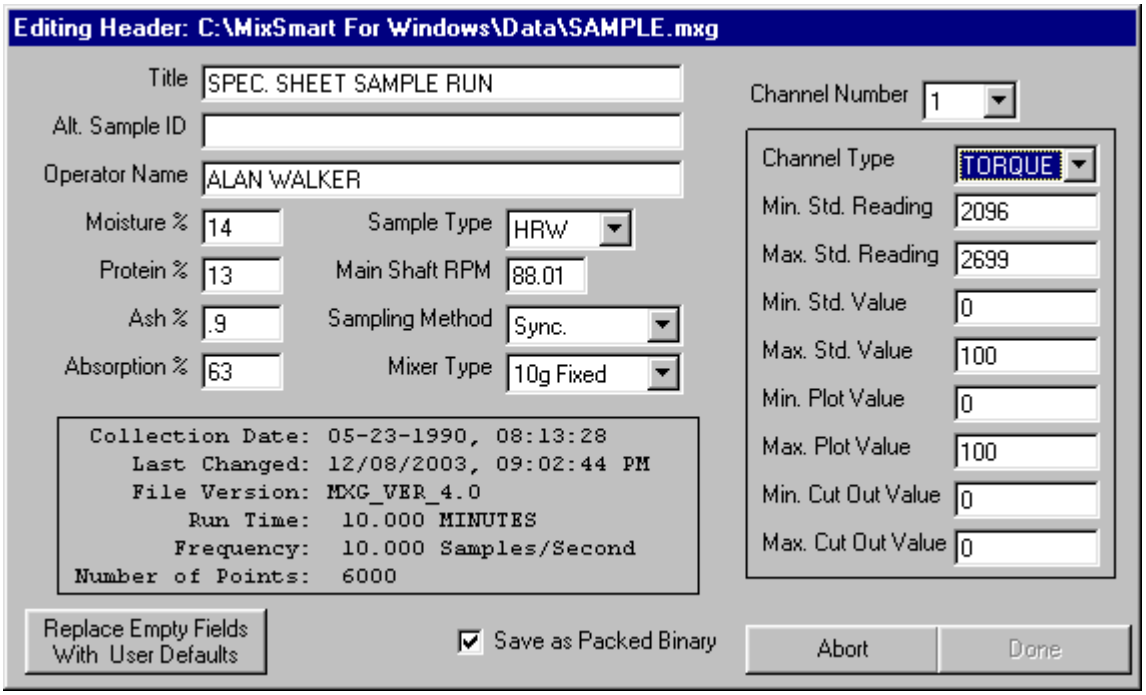
Utilities Menu



Some of the features available from this menu have been addressed at length earlier in the documentation. They will be briefly covered again in this chapter.

9.1 Edit .MXG Data File Header

The first option on this menu is used to view and alter the header section of a MixSmart raw data file. These files contain all of the actual data readings collected during a Mixograph run. They also contain calibration data and some user settings in effect at the time the data set was created. From here, the user can view all of these values and alter many of them. The chosen file is viewed or edited using the following form:



Most of these values are set by various defaults options prior to data collection and/or by a screen similar to this one at the time of data collection (see Section 3.4), but this screen allows the user to alter the values which were recorded with the .MXG file. Changes here do not affect any future data collections, but they are saved with this data file when it is closed. Note that this menu closely parallels Sections 10.6 and 10.8.

Title is the description which appears at the top of the text and graphics reports.

Alt. Sample ID is a general text field which can contain a submitter's sample ID in a contracted analytical lab or possibly a production line number in a factory QC lab.

Operator Name can be used to specify the default operator of the Mixograph (or of this MixSmart profile).

Moisture (%) is laboratory data provided by the user. This information is reported, but not used in normal data analysis. It may be used by custom .PGM modules. For Example, the moisture value, along with the protein field are used by the 'ABSPRED' module to estimate Mixograph absorption.

Protein (%) , same as above.

Ash (%), same as above.

Absorption (%), same as above.

Sample Type (%) is selected from a pick list. While not used during normal analysis it is displayed on the report and is available to custom modules. The available options are:

HDS	Hard Durum Spring
HDW	Hard Durum Winter
HRS	Hard Red Spring
HRW	Hard Red Winter
HWS	Hard White Spring
HWW	Hard White Winter
SRS	Soft Red Spring
SRW	Soft Red Winter
SWS	Soft White Spring
SWW	Soft White Winter
Other	Unclassified or non-wheat flour

Main Shaft RPM is used at data collection to calculate run time and sampling frequency for the 'Sync.' Sampling method. This information is not required for 'Timer' based data collection, although mixer speed certainly affects dough development. Not normally used in data analysis, it is still reported. RPM should be accurately recorded for future use and possible current use by custom .PGM analytical modules. Most Mixographs do not provide RPM data. For those that do, the 'Calibrate Sync. Sensor and Measure RPM' option described later in this chapter should be used to measure the value. In the absence of a measured value, the nominal setting of 88 RPM is suggested.

Data Sampling Method allows the user to choose the data collector's sampling method. The choices are:

Timer, Sync.

'Timer' is the common asynchronous, fixed clock method (typically 10 samples/second). The 'Sync.' method usually reads one sample every 120 degrees of Mixograph shaft rotation, starting at the home position. At 88 RPM this would seem equivalent to 4.4 samples/second, but the effects are more significant. The 'Sync.' system is most beneficial on fixed bowl (i.e. strain gauge and power monitoring) systems and is not recommended for moving bowl data collection. On current computerized Mixographs, 'Sync.' requires special sensor hardware. This and other hardware options are discussed further in Section 10.6.

Mixer Type allows the user to choose the Mixograph instrument type. The choices are:

2g Fixed, 10g Fixed, 10g Moving, 35g Fixed, 35g Moving, Other

'Fixed' and 'Moving' refer to the bowl mounting system and sensor type. Moving bowl sensors use a simple, reliable analog hall-effect sensor while the 10g and 35g Fixed typically have used a strain gauge sensor. The original 2g systems measured power draw.

Replace Empty Fields With User Defaults this button replaces all blank and zero valued user entries in a header with the current default values for the fields as defined in the 'Data Collection and Analog I/O Control' and 'Data Collection Sample Defaults' menus found under 'Preferences'. Run Time, Frequency, and calibration data are not replaced by this action. Amongst other things, this option can apply a default user set to older Mixograph files—files created before the extra header data was defined in MixSmart.

Save as Packed Binary, normally selected, indicates the internal format of the raw data in the .MXG file. Changes to this variable will affect the file when it is saved. For more information on the .MXG file packed format, see Section 10.6.

The right side of the header editor form presents one or more sets of calibration data. Most of these fields either assume a standard value or are not used by MixSmart. Also, the current version of MixSmart for Windows recognizes only the first raw data set (which must be of type 'Torque') found in an .MXG file. These other features foreshadow some further expansion of the product line—much of it based on past experimental efforts.

Channel Number is used to page the right side of this form through the data sets stored in the loaded .MXG file. While MixSmart for Windows will load multi-channel .MXG files, it only records single channel data sets and only the first channel of any file can be analyzed.

Channel Type describes the kind of raw data stored in the selected channel of the .MXG file. While listed here for completeness, only the 'TORQUE' type is currently recognized by MixSmart For Windows. This field should not be changed. The available types are:

TORQUE, PSI, THERM, FORCE, POSITION, IC

Min. Std. Reading, an integer, stores the sensor reading which corresponds to the Min. Std. Value entry on this screen. Used for calibrating the vertical scale and translating to real world units (% of full scale TORQUE, in this case), this value should be changed only with great care as it will alter all non-time results in a MixSmart analytical report. This value, along with the next one, is set up for a series of MixSmart data collection runs as part of the calibration process.

Max. Std. Reading, an integer, stores the sensor reading which corresponds to the Max. Std. Value entry on this screen. Used for calibrating the vertical scale and translating to real world units (% of full scale TORQUE, in this case), this value should be changed only with great care as it will alter all non-time results in a MixSmart analytical report. This value, along with the previous one, is set up for a series of MixSmart data collection runs as part of the calibration process.

Min. Std. Value should always be set to 0%.

Max. Std. Value should always be set to 100%.

Min. Plot Value is always recorded as 0% and should not be changed unless some unusual curve region is to be examined. Changing this value affects the graphics display only.

Max. Plot Value is always recorded as 100% and should not be changed unless some unusual curve region is to be examined. Changing this value affects the graphics display only.

Min Cut Out Value and
Max Cut Out Value are not used by MixSmart.

9.2 Data File Deletion & Renaming Utilities

Rename Data Files presents the list of .MXG data files found at the current Data File Path. The user may change a filename in this list by single-pick choosing and typing a new name for it when prompted. Illegal or duplicate file names are trapped and the user is allowed to try again or abort the renaming process.

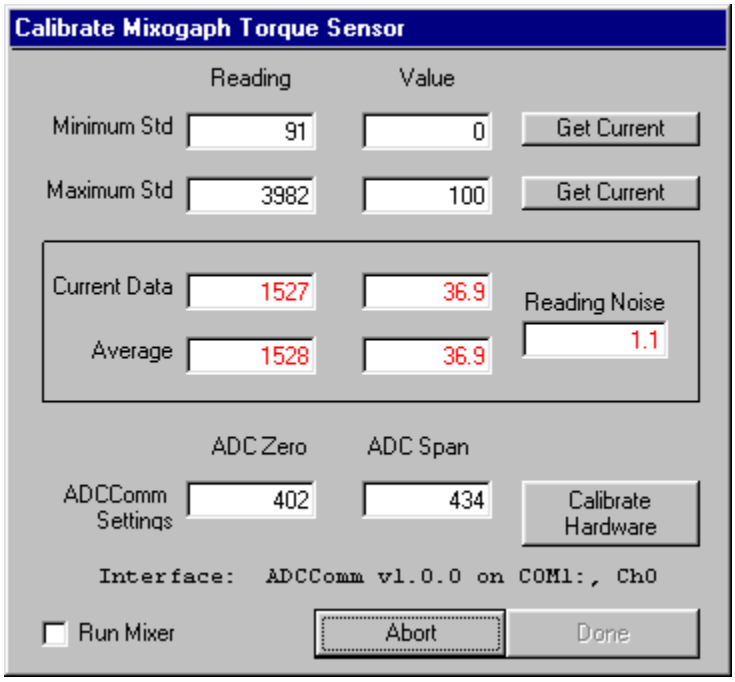
Delete Data Files presents the list of .MXG data files found at the current Data File Path. The user 'multi-picks' the files from this list which are to be deleted and presses Enter to commence.

Warning

Once confirmed and deleted, MixSmart deleted files are non-recoverable—they are not retrievable through the Windows 'Recycle Bin'.

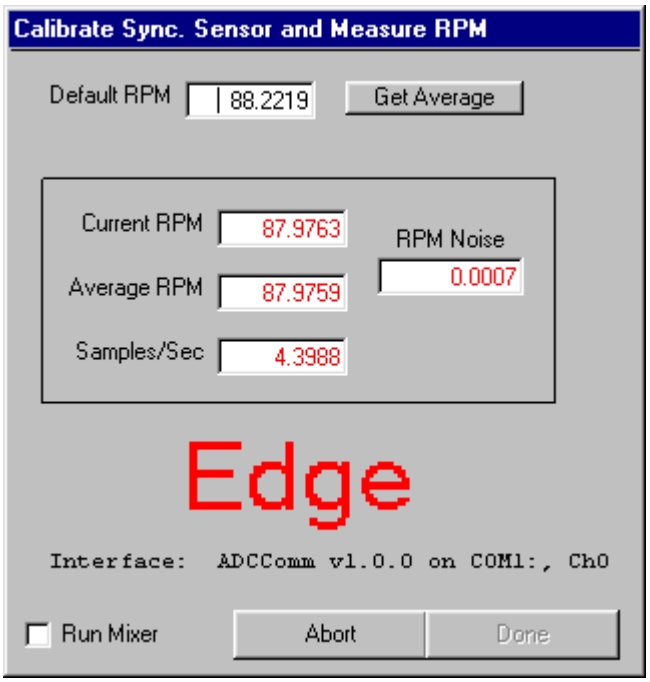
9.3 Calibrate Mixograph Torque Sensor

This feature was discussed in some detail during installation. The following screen is presented here for completeness only. The reader is directed to Section 3.3 or to the descriptions of the Min/Max variables in Section 10.6 for a thorough discussion.



9.4 Calibrate Sync. Sensor and Measure RPM

All computerized Mixographs which are adapted for synchronous sampling on the new interface are capable of measuring the mixer head RPM and recording it in the defaults variables. The following menu option allows this. It is also sometimes necessary to recalibrate the sampling angle or home position on such a Mixograph. These operations cannot be performed on Mixographs which support timer-based (i.e. asynchronous) data collection only. It is not necessary to choose 'Sync.' mode in the defaults variables options in order to use this screen.



To measure and record the Mixer's RPM, the user should first check the 'Run Mixer' box. After acknowledging an appropriate warning, the mixer will start and this screen should go 'live'. Every time a Tachometer sensor 'Edge' event occurs the Word 'Edge' will appear briefly on this screen and the information in the center box will update. When the Average RPM value has stabilized (possibly after an adjustment of the instrument), click the 'Get Average' button to transfer this reading into the Main Shaft RPM defaults variable (discussed in Section 10.6).

This screen can also be used to align the edge sensor and verify the edge type (see Section 10.6 again). In order to do this, the Mixer must not be running and the head must be free to turn under user control.

Warning

The mixer motor must not run during alignment work. Operator injury or instrument damage will otherwise occur. It is strongly suggested that the mixer motor (not the control electronics) be unplugged or otherwise disabled during this operation.

On a 10g or 35g unit, the user begins by loosening the set screw of the motor drive pulley (not the mixer head pulley). On later model, direct-drive Mixographs only, loosen the flexi-coupler from the Mixograph output shaft (which drives the planetary head assembly). These operations allow the head to be rotated clockwise to the home position as indicated by the mixer head pins alignment template supplied by National Mfg. The Mixograph Sync. sensor plate (on the top of the older 10g and 35g units) may then be rotated counter-clockwise until the computer 'beeps' indicating a home position. The user may need to rotate the sensor clockwise during these tests to find home, but only the 'Edge' message which occurs during sensor-plate counter-clockwise rotation should be used to indicate the home position. Once home is detected, lock down the sensor plate, remove the calibration template, and tighten the set screw on the drive pulley or shaft coupler.

Be sure to re-attach any shield removed during this operation, before the mixer is used again.

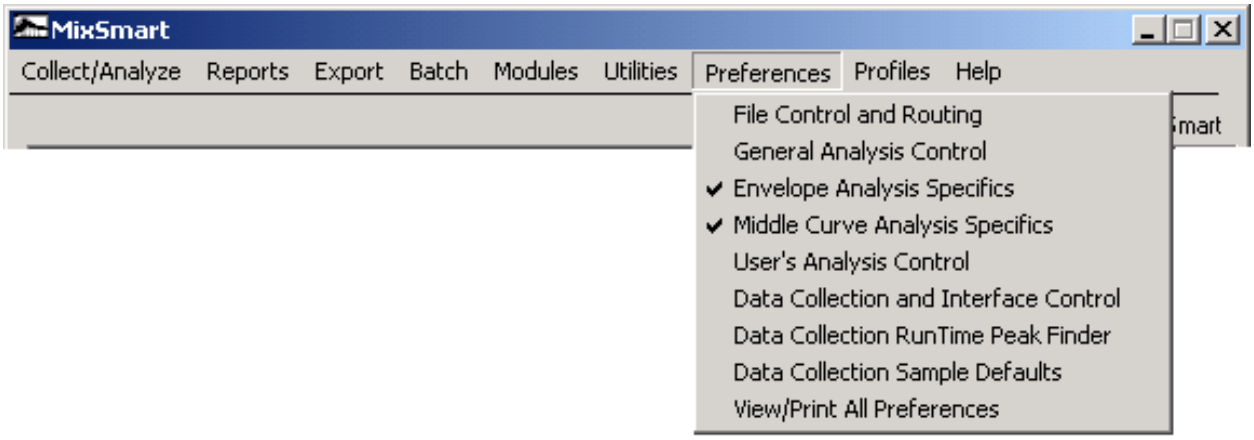
If it is not possible to shift the sensor interrupt/reflector disk enough to align with the home position, it is possible, although unlikely, that the Synchronization Edge has been incorrectly set. This is adjusted from the 'Data Collection and Interface Control' option under the Preferences menu.

Note

All Mixographs which support synchronous sampling are factory calibrated for home position and are unlikely to require physical adjustment.

Chapter 10

Preferences Menu



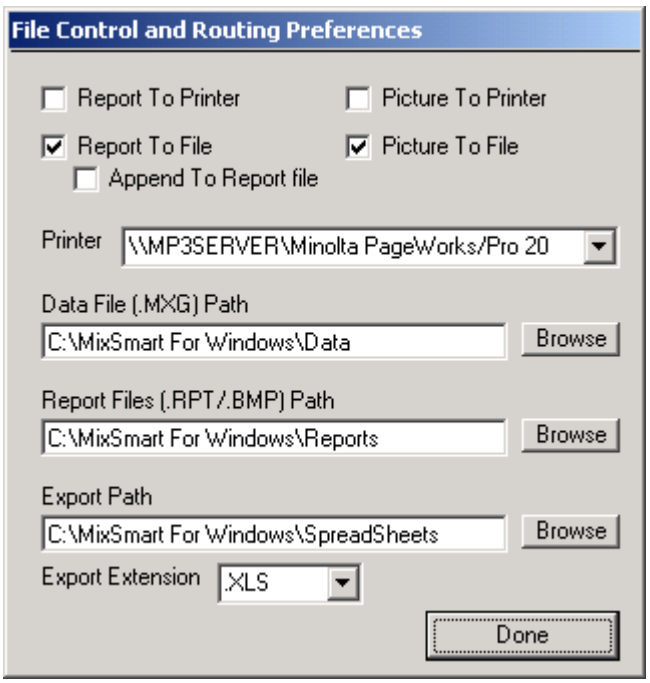
Most of the information which this program requires in order to collect or analyze a Mixograph data set is held in a table called the Mixograph Defaults Variables. Different versions of this table (called profiles) can be stored on disk and selected at start up. Some of the information in a profile is overridden by the contents of the data files when they are reloaded for analysis and all values may be altered by the Mixograph Batch File Processor during re-analysis.

This information can also be changed in a more permanent fashion which permits tailoring the analysis system to suit the hardware configuration of the particular Mixograph and computer being used, and the analytical needs of the user. Changing these tables is the main purpose of the Preferences menu and its sub menus. Shifting between or managing whole profile sets is handled by the 'Profiles' menu which is described in the next chapter.

All profiles are simple text '.INI' files stored in the MixSmart For Windows main directory. A valid file of this type must be present when the program loads.

In MixSmart For Windows, the defaults variables are no longer associated with a numeric 'Variable ID'. Variables are now identified for programming purposes by a 'variable name'. For example, the Mid Curve Filter value is referenced as "MidFilter". Most users will not need to know these names, but for those doing advanced work with the batch files or PGM modules, they are listed in Chapter 16.

10.1 File Control and Routing Menu



Report To Printer sends a copy of the finished text report to the MixSmart selected Windows Printer after an analysis completes (see 'Printer' later in this subsection). If the printer is not ready, an error message will be generated and report processing will terminate.

Picture To Printer sends a copy of the finished graphics to the MixSmart selected Windows Printer after an analysis completes (see 'Printer' later in this subsection). If the printer is not ready, an error message will be generated and report processing will terminate.

Whether or not the above automatic printing options are selected, the user may also click on the 'Print Report' or 'Print Plot' buttons which appear after an analysis finishes.

Report To File writes a copy of the finished text report (as a .RPT file) to the 'Report Files Path' folder. Note that the next option modifies this behavior.

Append to Report File controls the way in which data is written to the report file (if writing is enabled via 'Report To File'). When checked, each report generated under the same name (i.e. from the same raw data file and to the same report file path) does not replace any previous report file but is attached at the end of it. If the file does not yet exist, a new one is created. If this option is not checked, each 'same name' analysis replaces the one before. Appending reports is useful if the same data file is to be re-analyzed several

times with changes to the analytical variables-- for example setting different TIME_X or FILTER values. One report file containing all of these variations could be created for later study or export as multiple lines in a spreadsheet using the MixSmart Summary options.

Picture to File writes a copy of the finished analytical image (as a .BMP file) to the 'Report Files Path' folder.

Note

Using the 'Picture To File' option greatly increases the storage requirements for a data analysis. Storage requirements increase even more when data analysis is performed in 'full screen' mode on a PC with a high resolution Windows configuration.

Data File (.MXG) Path is a text variable managed by a directory pick-list. From here the user may select or create the path where MixSmart raw data files are stored. MixSmart data (.MXG files) can be organized into topical groups using this path control variable.

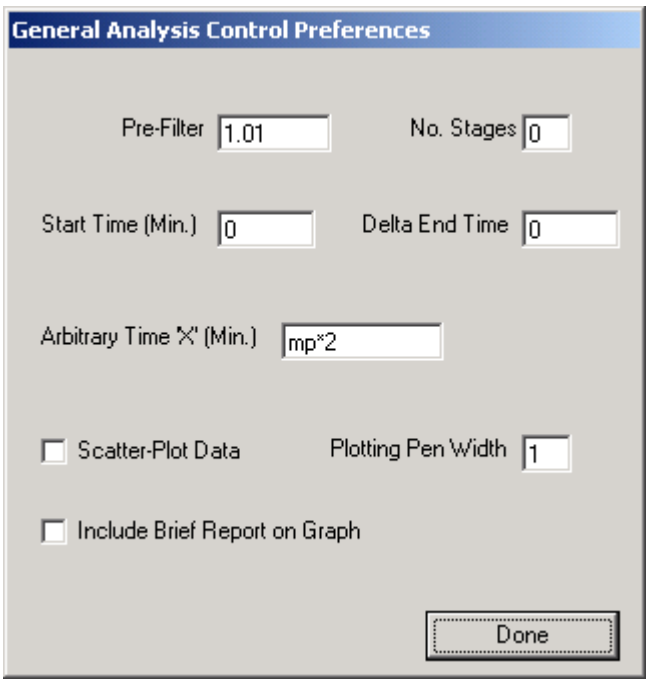
Report Files (.RPT/.BMP) Path is a text variable managed by a directory pick-list. From here the user may select or create the path where MixSmart report files are stored. This variable, along with the one above it, are the most likely to change if the user wishes to group data files and reports using different sub folders.

Export Path is a text variable managed by a directory pick-list. From here the user may select or create the path where export files (spreadsheet summaries) are stored. Note that the actual file extension (.???) is a user-selected value (see the next variable definition).

Export Extension allows the user to choose the file extension for the spreadsheet file being created. Note, however, that internally these files are always stored in Lotus (.WK1) format. This allows the user to set the file type for easy access by most spreadsheet programs including Quattro and Excel (both of which will correctly decode the file in spite of a misleading name). The available options are:

.XLS, .WK1, .QPW, .WB1, .WB2, .WB3

10.2 General Analysis Control Menu



Pre-Filter, a small decimal value, controls the degree of smoothing on the raw data before it is re-plotted and analyzed after a data collection or on re-analysis of an existing file. Typically ranging from 1.01 to 1.20, this value may not be less than one. See further discussion, next.

No. Stages, a small integer, is typically set to four (or set to zero to disable the effect). This term controls the selectivity of the Pre-Analysis filtering process much as the Filter Value and No. Stages variables for the mid line and envelope analytical sections control them. These variables, if used at all, should be set to very low effect (typically 1.1 strength by 4 stages) Such a setting will effectively smooth the 'fur' on curves collected from intrinsically noisy transducer systems like strain gauges and direct drive Mixographs.

Start Time, expressed in minutes, in most cases will be left as zero. It permits blocking the first part of the run (typically 0.50 minute) from consideration during the analysis because of occasional start up irregularities. Whether or not this term is used, all reported times are still measured from start of run. Very weak flours such as cake flours typically have a very "wild" start up, sometimes with a false peak. This option instructs the data analysis routines to ignore that section.

Delta End Time, expressed in minutes, this variable counts back from Total Run Time to mark an analysis boundary similar to the previous option. In this case, it instructs the analyzer to ignore the end of a run. Even though this

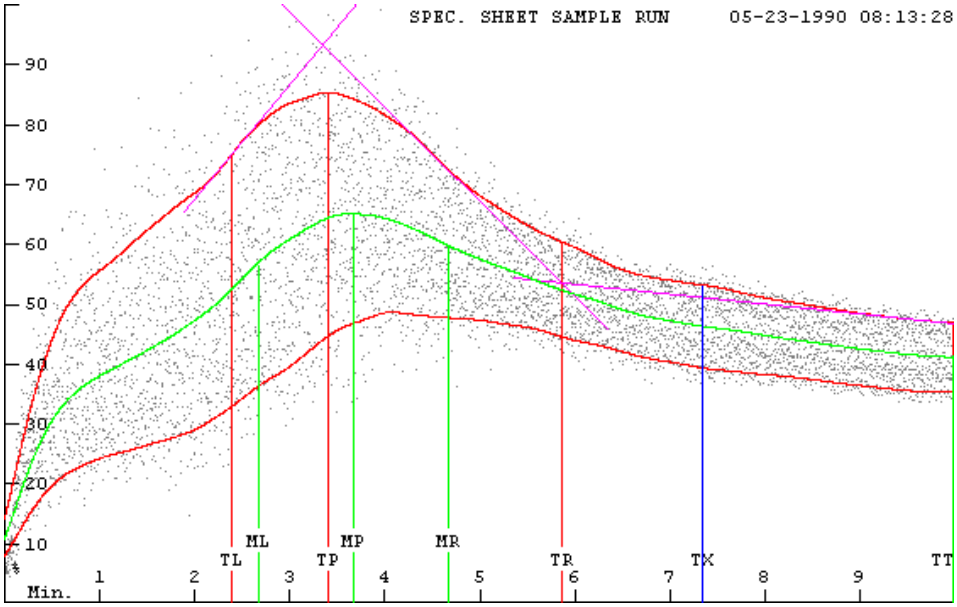
value counts back from the end of the run it should be expressed as a positive value. Typical values are 0.00 or 0.50 minutes. In conjunction with Total Run Time, this variable is used to calculate Curve_Tail time in the reports.

Arbitrary Time '**X**', entered in minutes, sets an arbitrary, user selectable time at which to perform a set of mid line and envelope analyses. The value can be expressed in one of six ways ('xxx' represents a decimal number):

0.00	Disables this feature.
xxx	Allows the user to specify an absolute time from start of run. Many people use a value of 8.00 minutes because this was the run time typically used on the older, non-computerized Mixographs.
MP + xxx	Allows the user to specify a Time 'X' at a relative point after the mid line peak. For example, 'MP + 2.00' would evaluate the curves two minutes after the determined middle peak time.
MP - xxx	Similar to the previous one, this option evaluates the curves at a relative point before the mid line peak.
MP * xxx	Evaluates the curves at a fraction of the mid line peak time, determined by multiplying the decimal value 'xxx' by the determined mid peak time. The multiplier can be greater or less than one, but must be greater than zero.
TP + xxx	Allows the user to specify a Time 'X' at a relative point after the envelope peak. For example, 'TP + 2.00' would evaluate the curves two minutes after the determined envelope peak time.
TP - xxx	Similar to the previous one, this option evaluates the curves at a relative point before the envelope peak.
TP * xxx	Evaluates the curves at a fraction of the top line peak time, determined by multiplying the decimal value 'xxx' by the determined top peak time. The multiplier can be greater or less than one, but must be greater than zero.

Scatter Plot Data forces the raw data points to plot without joining line segments during a re-analysis. This produces a 'scattering of points' which gives the user a very good idea of the actual portion of time spent in each of the plotted regions (i.e. top, middle, or bottom of curve). Normally not checked,

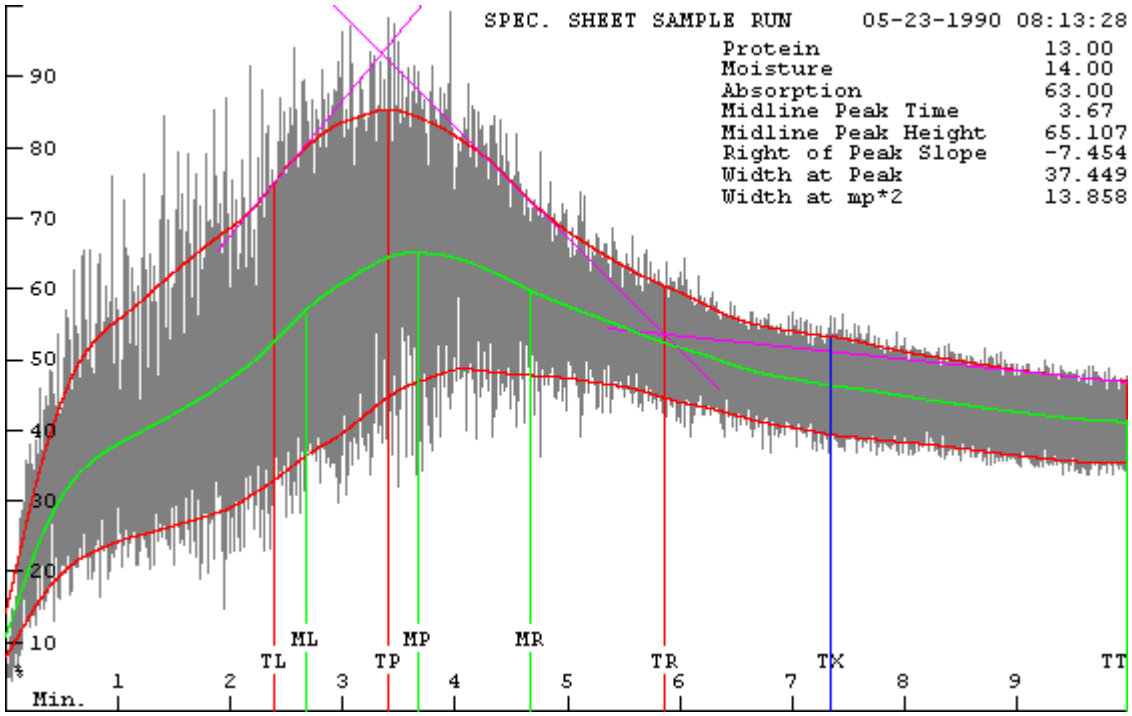
(and thus producing the typical mixogram appearance), this variable is used mostly for evaluating analytical techniques. The following sample graphics printout shows the effects of selecting this option.



While this variable significantly affects the way in which the curves appear, it in no way affects the analytical results.

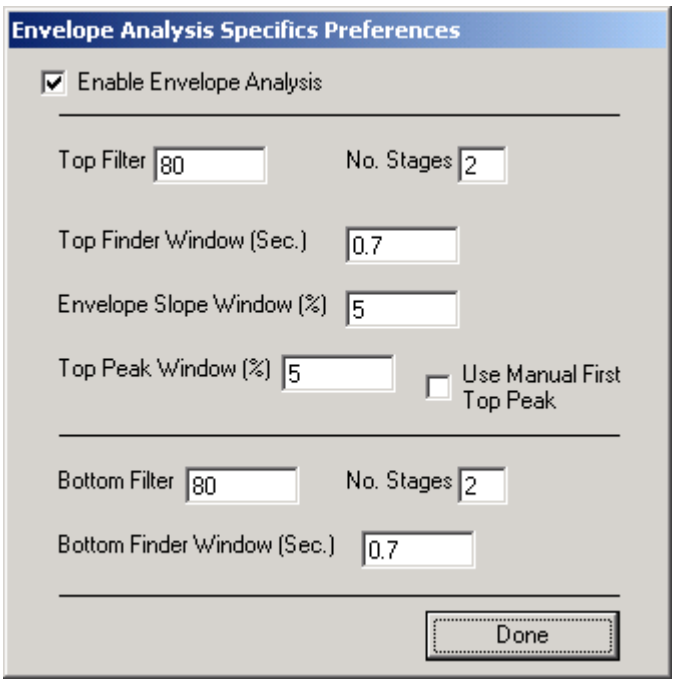
Plotting Pen Width, usually left as '1', allows changing the width of the lines used when re-drawing the raw data curve. A value of '2' will double the trace width, '3' will triple it, etc... Effectively reducing the horizontal resolution of the graphics display, this permits the user to make curve plots which look more like the old, mechanical Mixograph tracings, but it does not have any affect on the actual analytical routines in the program, nor does it affect the curve as it appears during data collection. Setting the Plotting Pen Width to zero suppresses the raw (or pre-filtered) data plot, displaying only the filtered curves and analytical lines. Some users may find this beneficial while preparing transparencies or for comparing curves.

Include Brief Report On Graph controls the placement of a small summary of the main analysis results in the upper right corner of the curve plot. This permits using only a single page for the results when graphical hard copy is required, but only very limited numerical results are needed. The following is a graphics printout on which this feature was enabled.



Please note that the first three lines of this text block refer to Flour Protein, Flour Moisture, and Mixer Absorption. This information is user supplied at data collection and stored in the .MXG file. The programmable extensions for MixSmart (i.e. PGM modules) also allow extensive customized control of on-screen reporting.

10.3 Envelope Analysis Specifics Menu



This screen enables or disables the entire envelope analysis function and controls its behavior. For an explanation of how these variables interact please refer to Section 13.3.

Enable Envelope Analysis activates the standard Envelope Analysis whose results are sent to the report text and graphics display. If this option is not selected, the entire envelope analysis is skipped. The filtered envelope curves are, however, still created (although not plotted) and are used to generate the width entries in the mid line report.

Top Filter, a decimal value, controls the degree of smoothing in the top curve. The larger this value, the flatter the curve will be and the less responsive to changes in the actual data. The smaller this value, the noisier the filtered curve will be and the more likely to cause false peaks and valleys in the analytical routines. A typical value is 80.

(Bottom) No. Stages, a small integer (1,2..5 etc) typically set to 2, this term controls the selectivity of the Filter value just discussed. To some extent, choosing a larger number of stages and a proportionally smaller Top Curve Filter will make the filter track the data better at the cost of slightly more processing time, producing a smooth, but 'bouncier' curve.

Top Finder Window (Sec.) and
Bottom Finder Window (Sec) are used to set the amount by which the envelope traces diverge from the mid-line curve using a 'Windowed Edge Tracker' method to generate the envelope curves. These values, normally equal, are usually in the range of .5 to 2 seconds. An older method of envelope generation, the Asymmetric Filter method, has been discontinued. This change is discussed in section 13.3.

Smaller numbers will more closely track the tiny fluctuations in the outer edges of the curve. Larger numbers will float further away from the mid line. These values should not be adjusted in order to smooth (filter) an envelope. They should only be used to place the curve. Curve smoothing should be done using the four filter variables (Top Filter & Stages and Bottom Filter & Stages) which are also defined on this menu.

Envelope Slope Window (%), typically 7.5%, represents the fraction of total run time to process when evaluating the filtered curve. These spans are used to calculate the left of peak and right of peak slope lines and time values for the "top of envelope" curve. Modifying this variable should only be considered if the analyzer cannot find the correct slope regions by adjustments to the Top Filter and No. Stages variables.

Top Peak Fit Window (%) sets the size (relative to total run time) of the region over which to perform the quadratic fit for top line peak height and time. Very narrow peaks should be fitted with a smaller window (about 2.5%) to prevent an inaccurate estimate of peak size. Likewise, very flat peaks may require a large window (about 10%). Peaks which are severely asymmetric (for example fast rise, but slow fall) may also require a small window to prevent erroneously extrapolating a peak outside of the reasonable zone.

This window based regression is performed even on peaks which have been manually 'first guessed'. For this reason it may be necessary to set this value to zero (0.0) if a user chosen first guess should not be adjusted by the analyzer.

Use Manual First Top Peak is normally not selected. The Top Curve Peak is typically determined by selecting a first guess peak time and then performing a simple quadratic regression on the area around it to determine the best time and value. The size of this regression zone is determined by 'Top Peak Fit Window'. The first guess peak is usually the highest value in the filtered curve. If this is causing the wrong area to be examined because of, for example, a false early peak, then selecting this option allows direct user intervention.

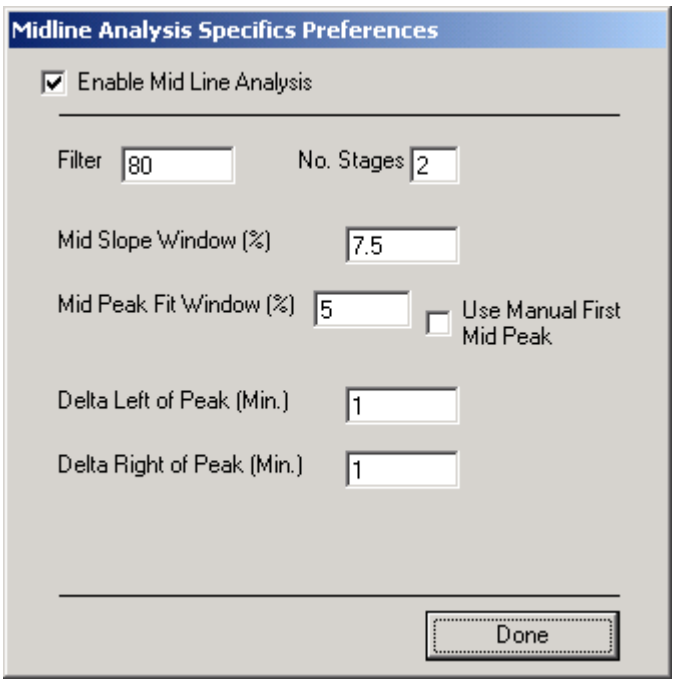
In this mode, the user is prompted to graphically select the correct search zone via the mouse or keyboard. After the analyzer plots the axis, raw data, and filtered top line, the user moves the mouse, dragging a vertical line (which

represents a new first guess time). Click the left mouse button to accept the current position of the line as a first guess or click the right button to cancel the entire analysis.

Once a new peak time has been selected, the analysis proceeds as usual, using the Top Peak Fit Window.

Bottom Filter and
(Bottom) No. Stages. These two variables perform the same function for the bottom of the envelope curve as the equivalent variables do for the top of the envelope.

10.4 Middle Curve Analysis Specifics Menu



This menu contains similar variables to the previous one, but as only one curve is generated, just one set of filtering variables is needed and envelope generators are not required.

Enable Mid Line Analysis activates the standard Midline Analysis whose results are sent to the report text and graphics display. If this option is not selected, the Midline analysis is skipped. The filtered midline curve is, however, still generated internally for use by advanced .PGM modules.

Filter, a decimal value, controls the degree of smoothing in the middle curve. A larger value here will result in a flatter curve which is less responsive to changes in the actual data. The smaller this value, the noisier the filtered curve will be and the more likely to cause false peaks and valleys in the analytical routines. A typical value is 80.

No. Stages, a small integer (1,2..5 etc.), typically set to 2, this term controls the selectivity of the Filter value just discussed. To some extent, choosing a larger number of stages and a proportionally smaller Mid Curve Filter will make the filter track the data better at the cost of more processing time and a smooth but 'bouncier' curve.

Mid Slope Window (%), typically 7.5%, represents the fraction of total run time to process when evaluating the filtered curve. These spans are used to calculate the left of peak and right of peak slope lines and torque values for the

"middle" curve. Modifying this variable should only be considered if the analyzer cannot find the correct slope regions by adjustments to the Filter and No. Stages variables.

Mid Peak Fit Window (%) sets the size (relative to total run time) of the region over which to perform the quadratic fit for the mid line peak height and time. Very narrow peaks should be fitted with a smaller window (about 2.5%) to prevent an inaccurate estimate of peak size. Likewise, very flat peaks may require a large window (about 10%). Peaks which are severely asymmetric (for example fast rise, but slow fall) may also require a small window to prevent erroneously extrapolating a peak outside of the reasonable zone.

This window based regression is performed even on peaks which have been manually 'first guessed'. For this reason it may be necessary to set this value to zero (0.0) if the user chosen first guess should not be adjusted by the analyzer.

Use Manual First Mid Peak is normally not selected. The Mid Curve Peak is typically determined by selecting a first guess peak time and then performing a simple quadratic regression on the area around it to determine the best time and value. The size of this regression zone is determined by 'Mid Peak Fit Window'. The first guess peak is usually the highest value in the filtered curve. If this is causing the wrong area to be examined because of, for example, a false early peak, then selecting this option allows direct user intervention.

In this mode, the user is prompted to graphically select the correct search zone via the mouse or keyboard. After the analyzer plots the axis, raw data, and filtered top line, the user moves the mouse, dragging a vertical line (which represents a new first guess time). Click the left mouse button to accept the current position of the line as a first guess or click the right button to cancel the entire analysis.

Once a new peak time has been selected, the analysis proceeds as usual, using the Mid Peak Fit Window.

Delta Left of Peak (Min.) instructs the analyzer where to find the left of peak value and slope. The time index for left of peak analysis is determined by subtracting this value from the mid line peak time as determined by the analyzer. A typical value would be one minute. Setting this value to zero suppresses its analysis, placing no line on the graph and leaving the report entry blank.

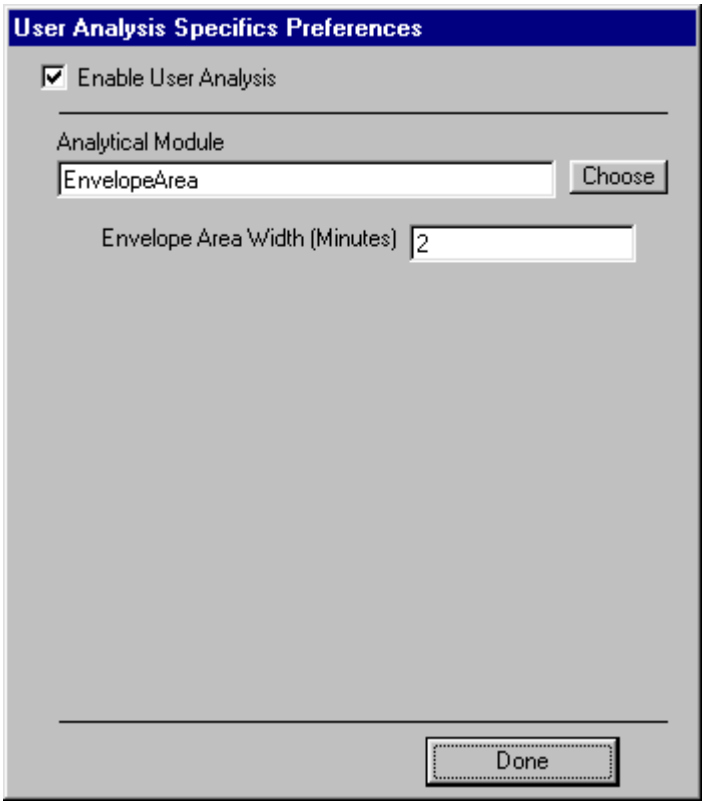
Delta Right of Peak (Min.) instructs the analyzer where to find the right of peak value and slope. The time index for right of peak analysis is determined by adding this value to the mid line peak time as determined by the analyzer.

A typical value would be two minutes. Setting this value to zero suppresses its analysis, placing no line on the graph and leaving the report line blank.

Note

Mid line slopes are taken at these relative times, with no reference as to their appropriateness. This is unlike the top-line analysis, which selects the times to measure slopes based upon actual curve characteristics such as inflection points and slope local maxima and minima.

10.5 User Analysis Specifics Menu



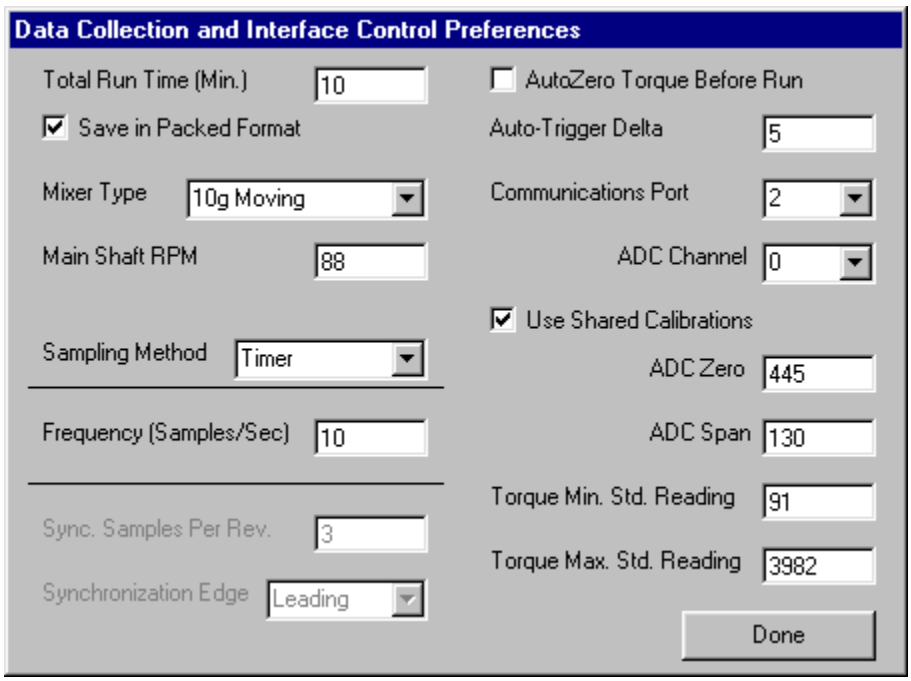
This form allows the user to embed fully customized and special use analyses in the standard MixSmart report structures. Extensive discussion and examples of the capabilities of the MixSmart add-in (.PGM) modules can be found in Chapter 17 and Chapter 18.

Enable User Analysis activates the selected analytical module in two parts. The first section of the file (EnvelopeArea.PGM, in this case), [PRELOAD], runs only once-- after the profile loads or any time a new .PGM file is selected. The second section, [USER] runs at the end of every MixSmart analysis, optionally generating additional output text on the report and potentially on the graphics screen. The [PRELOAD] section is responsible for activating and defining any of the user variables which could be present on this menu. In the above example, 'Envelope Area Width' is a custom variable defined by the EnvelopeArea module.

Analytical Module is a text variable managed by a file pick-list. It is used to select the custom module (.PGM file) which is 'bolted into' a standard MixSmart analysis. Choosing a new module while user analysis is enabled also runs that module's [PRELOAD] subsection if it is present. This can typically change the appearance of the menu, specifically setting up new user variables.

UserVar0—UserVar9 are completely controlled by the active PGM module. In this example, only the first one (UserVar0) has been defined as the field called 'Envelope Area Width'. These variables can be of numeric, text, or logical type. The variables defined by a .PGM module's [PRELOAD] section are hidden and inactive unless 'Enable User Analysis' is checked.

10.6 Data Collection and Interface Control Menu



Total Run Time (Min.) should be set to significantly exceed the last event of interest on the curve being collected. Ten minutes is a typical value.

Save in Packed Format controls the form in which the raw data file is stored after collection. In almost all cases the more compact, but less readable (to humans), packed option should be chosen. Files will load and save several times faster and require about 1/4 as much storage (@6000 points: 13,024 bytes vs. over 48,000). If the raw data will be used in other software, for example a database or spreadsheet, it may be necessary to save in the unpacked format. An existing data file can also be packed or unpacked by editing the .MXG file header via the Utilities Menu (see section 9.1).

Mixer Type allows the user to choose the Mixograph instrument type. This is recorded with the data file and appears in the defaults variables section of the report. The choices are:

2g Fixed, 10g Fixed, 10g Moving, 35g Fixed, 35g Moving, Other

Main Shaft RPM is either specified by the user through this menu or read from the Mixer via the utilities menu. This value is used to calculate run time and sampling frequency when using the 'Sync.' sampling method. If this value is erroneous, synchronous data collection sessions may report a 'Sync-Loss or RPM Error'. Note that older 10g and 35g Mixographs do not support 'RPM' reporting. For these machines the user must make his own calculation or take the default of 88.0 RPM.

Sampling Method allows the user to choose the ADCComm's sampling method. This information controls the collection system, but is also stored with the data file and appears in the defaults variables section of the report. The choices are:

Timer, Sync.

'Timer' is the common asynchronous, fixed clock method (typically user set to 10 samples/second). The 'Sync.' method samples periodically in synchronism with the mixer head. This is typically every 120 degrees of shaft rotation, starting at the home position, but can be adjusted using the 'Sync. Samples Per Rev.' setting. At 88 RPM, the typical setting would seem equivalent to 4.4 samples/second, but the effects are quite different. The 'Sync.' system is most beneficial on fixed bowl (i.e. strain gauge and power monitoring) systems as it reduces spurious pin noise. On current computerized Mixographs, 'Sync.' requires special sensor hardware, installed by National.

Frequency (Samples/Sec), is only used when the Sampling Method is set to 'Timer'. In combination with 'Total Run Time' it determines the total number of data points to be recorded. The old limit of 25,000 points maximum per run has been eliminated in MixSmart for Windows, but less is still generally better. If the user wishes to calculate the number of samples to be collected the equation is:

Number = (Total Run Time) * (Frequency) * 60.

Typically a run will last for 10 minutes @ 10 points/second, recording a total of 6000 points. Given a machine of sufficient power (Pentium III class), it is actually possible to sample a single channel at rates as high as 125 times/second. However, sample rates above 10 Hz offer no practical improvements in Mixograph analysis and significantly slow down the data analysis. On the other extreme, sample rates below 10 Hz can cause 'Aliasing', a sort of beat frequency interference caused by the Mixograph's own harmonics.

Experimentation has shown that 10 samples/second is a near ideal sample rate for the Mixograph (See Chapter 15 for a further study of this).

Note

The ADCComm electronic interface normally supplied with this software pre-filters the signal to eliminate noise (and data) content above 25 Hz. Sampling at higher frequencies requires modifying this device.

Sync. Samples Per Rev. must be set to reflect the configuration of the optical position sensor on Mixographs equipped for Synchronous sampling. Typically,

set to 3, it indicates the number of samples expected for each revolution of the Mixer's main shaft. The default value (3) should not need to be changed and is unused during 'Timer' based sampling. It is used during Synchronous Sampling and while measuring RPM.

Synchronization Edge, normally set to 'Leading', configures the position sensor's trigger polarity during Synchronous mode. It has no effect during 'Timer' based data collection. Its possible values are:

Leading, Trailing

AutoZero Torque Before Run, when selected, uses a continuous evaluation of the baseline of the analog data to adjust the maximum and minimum plot values when collection is actually triggered. Checking this box changes the Torque Min. Std. Reading to the new observed baseline and changes the Torque Min. Std. Reading to maintain the previous difference between the Max and Min values. Algebraically this is expressed as follows:

Min_{new} = Observed Baseline
$Max_{new} = Min_{new} + Max_{old} - Min_{old}$

The status of this variable is displayed on the pre-trigger screen at the beginning of data collection. It is important to remember that setting this flag does not free the user from using the calibration screen to set Max and Min. Calibrate Mixograph Torque Sensor (on the utilities menu) is still used to set the expected span and to perform adjustments on the ADCComm interface. However, with the AutoZero option enabled, manual calibration will not need to be used as often.

This option is most beneficial for strain gauge interfaced Mixographs as the baseline drifts a bit. Power monitoring, direct drive units like the two-gram have very noisy baselines which are not suitable for this option. Moving bowl systems (the typical 10 and 35-gram units) tend to have very stable baselines, but can be coincidentally off of the zero mark during startup. For this reason, the AutoZero function is not recommended here either.

Note

Calibration changes brought about by selecting this option are not permanent. The updated Min and Max variables are saved with the newly created data file, but revert to the profile's Min and Max defaults for the next data collection. Permanent changes to these variables should be made via the calibration screen on the utilities menu or via direct entry on this control menu.

'AutoZero Torque Before Run' is further discussed in the description of the next field, 'Auto Trigger Delta'.

Auto Trigger Delta, expressed in the same units as the incoming (raw) Mixograph data, controls the start of data collection.

After filling in the file name and any other customizations on the 'Preparing to Collect Data' screen, the user clicks 'Continue' to enter the pre-trigger data collection screen which contains three lines of information. The first of these three lines identifies the stimulus required to begin collecting data. This line can say one of two things:

```
Auto-Trigger is Disabled..... Click 'Start Now' to begin.
```

or

```
Waiting For Auto-Trigger (Delta = nn)
```

If the Auto-Trigger Delta variable is set to zero, data collection can only be started via the 'Start Now' button.

If 'Auto-Trigger Delta' is set to a non-zero number, the program will continuously sample the analog port at 10 readings per second. These readings will contribute to a sliding 10 reading (1 second) average of the baseline. Each reading will also be individually compared to this baseline. If the absolute difference between the newest reading and the current average is equal to or exceeds the Auto-Trigger Delta value, collection will begin. This process should not be confused with the 'Auto Zero Before Run' option which also uses the running baseline average.

The value chosen for this variable should be greater than the maximum noise encountered in the Analog to Digital sampling circuitry as observed in the Calibrate Mixograph Sensor option in the Mixograph Utilities Menu. Typical settings are from 2 to 7.

A point to consider: Auto-triggering greatly improves the simplicity and reliability of data collection but doesn't start things until some very small portion of the rapidly rising torque plot has slipped by (typically less than two seconds). As the noise threshold is critical to keeping the trigger value small and consequently this time error small, any significant chatter in the readings from an idle machine should be investigated. For the equipment involved, significant chatter could be considered any random variation of five or more units over the course of a minute. The strain gauge interfaced systems are the most naturally noisy, while the 'Hall-pot' based, moving bowl systems are the quietest.

The second line in the center of the pre-trigger screen describes whether the current baseline calculations (as displayed on the third line) will have any

influence on the Minimum and Maximum Plot Values. This line can take one of two forms also:

```
AutoZero is Disabled.... Default Min/Max values will be Used
                              or
AutoZero is Enabled.... Default Min/Max values will Be Adjusted
```

These two possibilities are described in the previous entry (AutoZero…).

The last line in the center of the pre-trigger screen is always present. It continuously displays some primitive statistics on the analog data. The line has the following form:

```
Current Baseline: mmmm       Average Noise: nnn
```

The first number, 'mmmm', is the running average of the analog readings as the system sits waiting for the trigger event ('Start Now' button or Auto-Trigger). The analog data channel is sampled at 10 times per second, producing a new one second average every 0.1 seconds. For each of these one-second sample sets the average noise is calculated and displayed. This information can be used to track changes in wiring conditions or to identify rough bearings in the direct drive units. It is also useful as a reference when determining an Auto-Trigger Delta value.

Communications Port allows selection of the Serial port by which the ADCComm unit is attached to the PC. Typically the port will be either '1' or '2' (corresponding to COM1: or COM2:), but other values are possible. This is usually set once during a profile's initial configuration and never changed again. See Section 3.1 for further information.

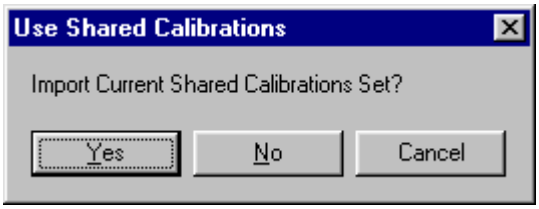
ADC Channel is typically set to '0' when the ADCComm is attached to a Mixograph. The interface can support up to 4 different analog (sensor) inputs, labeled Channel 0 to Channel 3. However, the first one may be all that is installed when shipped for Mixograph use.

Use Shared Calibrations allows the following four variables, all specific to the interface and instrument, to effectively be shared between multiple user profiles. When set to 'True', MixSmart replicates the calibration variables (ADCSpan, ADCZero, TorqueMinStdReading, and Torque MaxStdReading) to another file called 'Calibration.inf' when the profile is subsequently saved. Any profile with this value set at the time it is loaded will have its calibration values overwritten by the contents of the Calibration.inf file.

Rare circumstances (instrument testing and repair, or unusual sample material) may require that a given profile's calibration variables be isolated from the master set. When this is necessary, simply set 'Use Shared

Calibrations' to 'False' before saving the profile that has been altered. Remember that exiting the program or shifting to another profile within MixSmart automatically saves the current profile (potentially updating the shared settings). 'Save Current Defaults as a new Profile' also potentially updates the Calibration.inf file as it creates a new profile by copying the active one.

If Shared Calibrations are currently inactive and this option is checked the following dialog is presented:



By choosing 'Yes', the user can immediately import the current shared values. Selecting 'No' will retain the calibrations already present in the loaded profile, potentially using them to overwrite the shared data when the profile is saved. Choosing 'Cancel' returns to the preferences menu without changing this defaults variable or modifying any of the calibration data.

ADC Zero (range 0—1023) programs the offset for the selected channel of the ADCComm unit. This value produces an internal reference voltage (0 to 5v) which is subtracted from the analog sensor voltage before it is amplified (see 'ADC Span') and converted to its final digital form. This value and the next one described are normally set via the automatic 'Calibrate Hardware' function on the 'Calibrate Mixograph Torque Sensor' screen.

ADC Span (range 0—1023) programs the gain of the ADC chip in the ADCComm unit by setting the maximum voltage span (0 to 5v) required to generate a full-count digital output. Like ADC Zero, above, this is normally set via the automatic 'Calibrate Hardware' function on the 'Calibrate Mixograph Torque Sensor' screen.

Torque Min. Std. Reading and
Torque Max. Std. Reading are critically important to the conversion of raw Mixograph data to percent values. Traditional Mixographs have a strip chart recorder attached to them. The paper for this recorder is broken into ten zones vertically so that curve height and bandwidth can be measured directly in percent-- each division of the paper being 10 percent. This scaling convention has been carried over to the computerization.

The 'Max.' value on this screen should be set to the reading obtained from the ADCComm interface when the Mixograph is positioned at 100% of scale.

'100% of scale' may be defined as a certain amount of 'pulley weight' on the fixed bowl/load cell systems, as a specific bowl angle or pen position on the moving bowl systems, or as a certain output voltage or dynamic load on the new, direct drive, recording mixers.

The 'Min.' value should be set to the reading obtained from the ADCComm Interface when the Mixograph positioned at 0% of scale. '0% of scale' may be defined as no stress on the fixed bowl/load cell systems, as another specific bowl angle or pen position on the moving bowl systems, or as a minimum output voltage on the direct drive units.

The actual numbers needed here are obtained by running the 'Calibrate Mixograph Torque Sensor' option from the Utilities Menu under the conditions described in Section 3.2, and transferring the results to these variables. This transfer may be manual, or it may be done automatically from the calibration screen. This re-calibration process will need to be done whenever the equipment is moved or has been subject to excessive stress (as in an awkward bowl removal in the fixed bowl/load cell configuration). In practice, calibration should probably be verified at the start of each work session and as a check at the end of longer sessions as well.

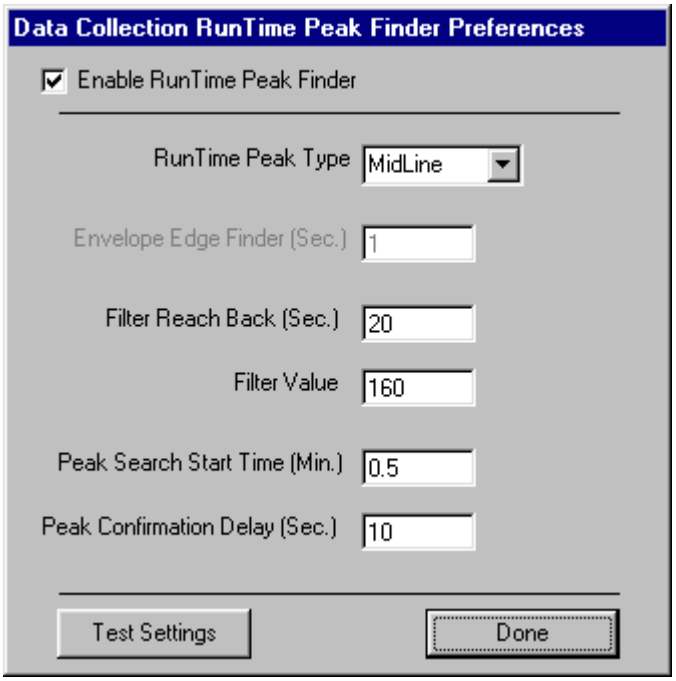
If the user has checked 'Auto Zero Torque Before Run', much of the sample-to-sample drift of the strain gauge units can be ignored as it will be compensated for in the automatic adjustment of the baseline. However, calibration tests on the maximum and minimum loads should still be done once per session to verify that the range (which is preserved in the automatic baseline adjustment) is correct and also to check that the readings have not drifted beyond the analog to digital converter's ability to capture them.

The Torque Min. Std. Reading and Torque Max. Std. Reading variables are stored at the head of each raw data file to assure consistent re-analyses. These values can be over-ridden through the MixSmart batch file processor or they may be permanently changed in an MXG data set via the header editor on the Utilities Menu.

Note

Changing or over-riding the Maximum and Minimum Std Readings imbedded in an MXG data file should not be lightly considered, as this can alter every non-time result on a report.

10.7 Data Collection Run Time Peak Finder Menu



This menu describes a fairly new feature to MixSmart. In response to the many users who sometimes employ the Mixograph as a bread making mixer (albeit of very small loaves), we have added this function which estimates the peak time from the running data collection and terminates collection when it finds a peak. When the peak is found the raw data to that point is saved and MixSmart either returns to the main menu or performs a standard analysis as the user has selected.

Mixographs which support computer controlled startup and shutdown are also shut-off at this point. All new machines will eventually support this feature. Mixographs which do not support automatic shutdown require that the user react to data collection termination by manually shutting down the mixer. However, this attentiveness is not unreasonable as the technician must be intending to use the dough immediately after collection anyway.

If the Mixograph run is intended for MixSmart analysis of the flour only and no subsequent use is planned for the dough, then more consistent and complete results will be obtained from the standard analysis if this feature is disabled and the software allowed to run for the full time period.

Enable Run Time Peak Finder sets MixSmart data collection to stop when a peak is detected using the criteria set by the other variables on this menu. Note: if no peak is found, the curve will still be saved at 'Total Run Time'

Runtime Peak Type allows the user to terminate data collection based on a mid line peak or based on an envelope peak.

Envelope Edge Finder (Sec.), typically set to one, is used only when 'Runtime Peak Type' is set to 'Envelope'. This variable controls the 'float' of the envelope curve in the same manner as the Top Finder Window in the Envelope Analysis Specifics menu.

Filter Reach-Back (Sec.), typically set to 20, controls how large a subset of curve data is used to determine a filtered 'potential peak' value for the current data point. Since only previous data points exist at the moment any given data point is acquired, the filtering subset always 'reaches back' to earlier values. A great deal of processing power is required to look for a peak while collecting data. Slower machines may need to reduce the Reach-Back value. Older computers (Pentium II 266Mhz and slower) may be unable to detect run-time peaks without losing data points.

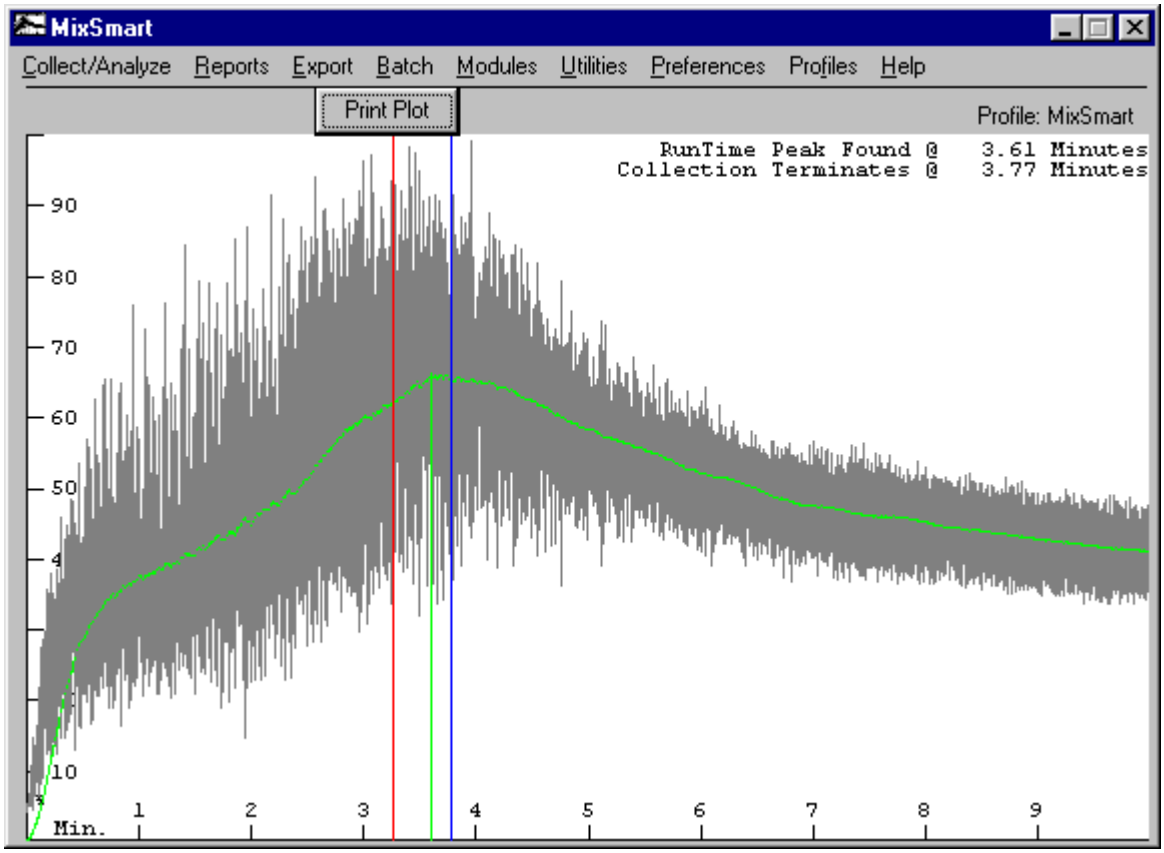
Filter Value, typically set to 160, works much as the filters do for the standard midline and envelope analyses. Since only a single stage filter process is used here, larger values are recommended.

Peak Search Start Time (Min.) defines a 'skip zone' before which no peak will be sought in a running data collection. This prevents false triggering from spurious data at the beginning of a run and can also be used to eliminate false peaks (sometimes called 'hydration peaks') which may occur later in the run, but before the true maximum.

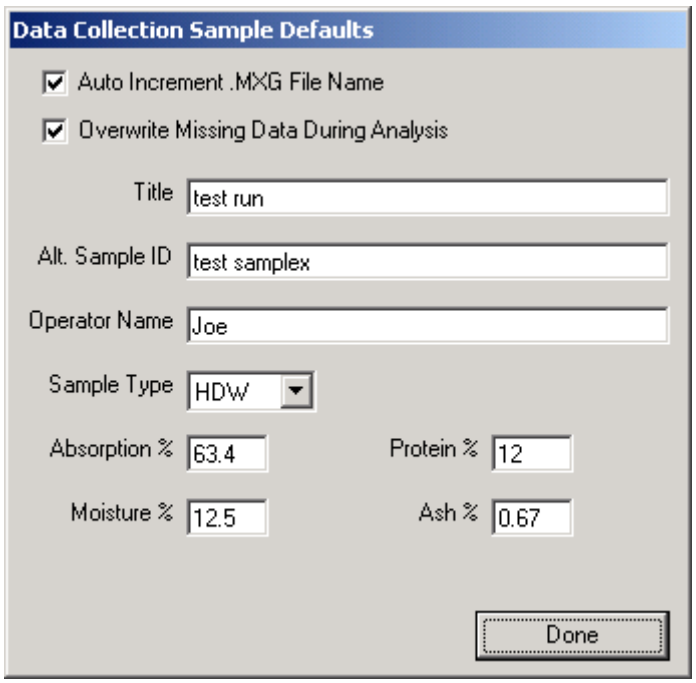
Peak Confirmation Delay (Sec.), typically 10 seconds, controls the degree of certainty required before a local peak will be declared the true answer. In other words, a value derived by the filtering algorithm is considered a run-time peak if it is larger than any previous value (back to the 'Starting Search Time') and continues to be the largest value for the next 'Runtime Peak Confirmation Delay' seconds. Making this value larger assures that a small, spurious spike won't be erroneously selected, but delays run termination. Another consideration is that of subsequent analysis. The MixSmart report generator relies on a brief 'post peak' period to fit the curve. This can be hampered by a very short Confirmation Delay.

Test Settings is used to test these options by selecting an existing data file and processing it through the data collection system. Just as in real data collection mode, the filtered data points of the runtime analyzer plot on the screen. These lag the raw data by "Envelope Edge Finder' seconds, if the Envelope curve has been chosen. After 'Confirmation Delay' seconds, a red vertical line is plotted to mark the beginning of the filtered subset. Next, a vertical green line marks the actual determined peak time and approximate value. Finally, a blue line marks the end of the 'Peak Confirmation Delay' period. The plotting simulation continues to the end of the data set when a two line summary is written to the screen and the user is given a button to print the plot, if desired.

The following screen is an example of the Test Settings function:



10.8 Data Collection Sample Defaults Menu



Auto Increment .MXG File Name, when checked, MixSmart attempts to compose each new, suggested .MXG file name as an integer increment of the one before. This process only works if the first file name entered includes at least one digit at its end. Also, the auto-increment operation will roll over to all zeros if all digits reach '9' on the last use. In other words, the file name will not get longer to accommodate a larger number so care must be taken not to roll over data file names, causing a new file to write over an existing one (although a standard warning is issued if an .MXG file already exists). As a suggestion, users of this feature may wish to end any new .MXG filename with '01' (or some other starting value).

Overwrite Missing Data During Analysis specifies replacing missing user data fields (for example Moisture or RPM) with the data collection sample defaults during report generation. This is useful when working with older .MXG files where user data fields are not available. However, changing these values permanently using the data file header editor on the Utilities menu is the recommended long-term solution.

Title sets the default title for each .MXG data set collection. This value can be altered at data collection time.

Alt. Sample ID can contain a submitter's sample id in a contracted analytical lab or (possibly) a line number or shift id in a factory QC lab. It may also be overridden at data collection time.

Operator Name, is used to specify the default operator of the Mixograph (or of the current MixSmart profile). It may be overridden at data collection time. This data or its override is recorded with the data set in the .MXG file.

Sample Type allows selecting the default sample type (usually a wheat variety) from a list. This data or its override is recorded with each .MXG file. The options are:

HDS	Hard Durum Spring
HDW	Hard Durum Winter
HRS	Hard Red Spring
HRW	Hard Red Winter
HWS	Hard White Spring
HWW	Hard White Winter
SRS	Soft Red Spring
SRW	Soft Red Winter
SWS	Soft White Spring
SWW	Soft White Winter
Other	Unclassified or non-wheat flour

Asorption %, laboratory data provided by the user, sets a default value for data collection which may be overridden. This information or its override value is recorded in each .MXG file.

Moisture %, same as above.

Protein %, same as above.

Ash %, same as above.

10.9 View/Print All Preferences

This simple option, available directly from the Preferences menu sends a formatted table of the current defaults to a browser window. This lists the internal name, description, data Format, and current Value for each setting. The internal name is used when working with the Mixograph Batch File processor (accessible from the main menu and explained elsewhere). These names are also used to access default variables from within PGM modules.

The data format defines the type and range of information stored. The following formats are used:

##.#### Standard real and integer numbers, common formatting syntax.

str Text variable, while not limited by the format, the length may be restricted by menu and report formatting.

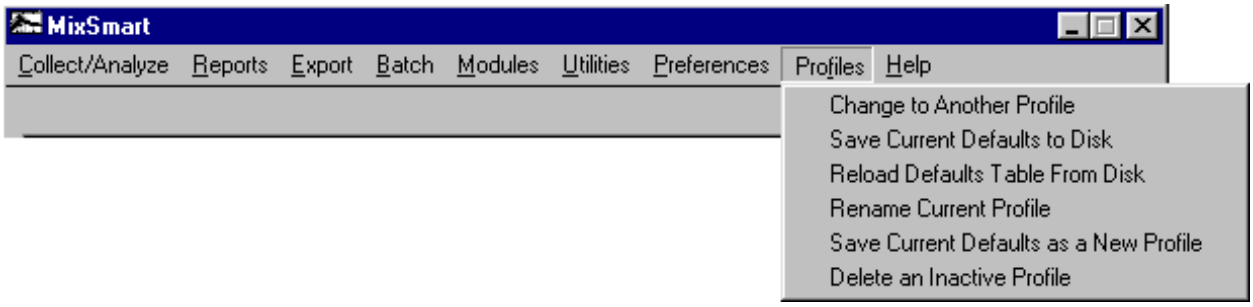
boo Boolean format. These variables can only assume the values of 'True' or 'False'. Typically these are represented by check boxes in the defaults editor. A checked box implies a True value for that variable.

Some variables are for internal use only, but can be read and modified in batch files and PGM modules. Temporary variables, typically assigned when a .MXG data set loads for analysis are important to batch file and .PGM users. Both the internal and the temporary variables are discussed in Chapter 16.

Conclusion
This completes the menu-oriented journey through the defaults variables. As these entries control nearly all aspects of this software, they are further explained in other places in this documentation. After a little experience, the user will find that only a handful of them are changed very often.

Chapter 11

Profiles Menu



Change To Another Profile allows the user to jump to a different .INI file, automatically saving any changes to the current set. The selection list for choosing a new profile will not include the current profile.

Save Current Defaults to Disk writes the (possibly) modified MixSmart profile out to disk. This action is also be performed automatically, if any changes were made to the variables, when the user exits the program or switches to another profile. Forcing a save of the defaults variables tables is generally not necessary.

Reload Defaults Table From Disk provides a simple way to undo all the changes made to the current defaults profile since it was last loaded. It may be thought of as an editor bailout command. Remember that 'Change To Another Profile' always saves any changes in the active profile before switching out.

Rename Current Profile allows the user to change the name of the currently active defaults (.INI) file. Duplicate profile names are not allowed.

Save Current Defaults as a New Profile saves a new profile using the current defaults variables values (including any changes which have not been saved). The active profile is changed to this newly created file. The previous profile is not updated with any of the changed values.

Delete an Inactive Profile allows deletion of a user selected .INI file. The user must confirm this removal. The currently active profile is not presented here and cannot be deleted.

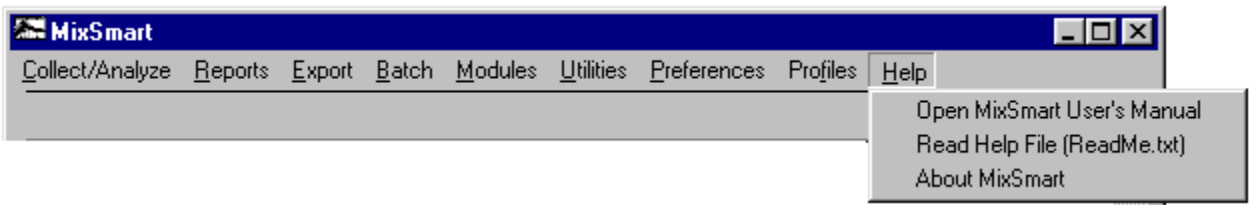
Warning

Do not by some means remove all profiles from a MixSmart installation. If this happens, MixSmart For Windows will not work

until at least one is restored from a backup or from the installation CD.

Chapter 12

Help Menu



Open MixSmart User's Manual allows the user to open and read the full users manual in Adobe PDF format. This option requires that acrobat reader 4.x or later be installed. This free utility is available for download on the Internet.

Read Help File (Readme.txt) allows the user to browse the most recent release notes for the software.

About MixSmart gives the user another look at the title and copyright screen displayed whenever the program starts. This screen contains important information about the version and release date of the software and may also include the identity of the authorized user. Users calling National Mfg. for technical assistance will be expected to provide this information.

Chapter 13

Understanding and Controlling the Analysis

Pretty though a software package may appear, none of its bells and whistles are any good unless its analytical routines and report generator can provide meaningful, consistent results. The intention of this software from its beginning was not to create another school of thought regarding the methodology of mixogram analysis, but rather to emulate the methods currently in use. The envelope analysis section addresses this need. With the addition of the mid line section, the integrals, and the customized .PGM modules, MixSmart provides additional data which is now also accepted as meaningful.

Beginning with (DOS) MixSmart v4.00, a third form of analysis, the User or '.PGM' method was added to provide great versatility both on the text reports and on the graphics screen. The PGM section allows custom programming modules which can draw from the data, defaults variables, and standard reports to produce new results that can be inserted into the analysis output. This permits completely new and different forms of curve evaluation and very efficient generation of variations on the current analytical methods. While discussed some in this chapter, detailed use and construction of the .PGM modules are described in Chapters 8 and 17.

The analytical core of MixSmart has been stable for some time and shows strong correlation with manual curve evaluation. Computerized analysis of the mixogram has become the standard for Mixograph curve evaluation.

Note

The most important things to remember in applying the techniques described in this chapter are documentation and consistency. Most changes to the analytical procedures will be automatically noted on the report form, but the user is strongly urged to record why they were made. Changes of this sort, if truly necessary, should be applied to as complete a group of samples as possible. Using two or more different defaults variables configurations within a supposedly similar sample block can introduce analytical artifacts that do not come directly from the flour itself.

13.1 Graphical Display

Each of the times in the envelope and mid line report sections is represented graphically as a vertical line which overlays the data. These lines are identified by two letter codes at their bases. These codes can sometimes overlap making interpretation from just the image difficult. The two letter codes are as follows:

Analysis	Envelope	Mid line
Left_of_Peak	'TL'	'ML'
Peak	'TP'	'MP'
Right_of_Peak	'TR'	'MR'
Curve_Tail	'TT'	'TT'
Time_'X'	'TX'	'TX'

In all cases, except for Time_'X', the vertical line terminates at the location for the value on the appropriate curve at that time. In the case of the envelope analysis, the tangent lines associated with Left-of-Peak, Right-of-Peak, and Curve-tail are also plotted. To avoid clutter, the mid line tangents (slopes) are calculated and reported, but not plotted.

The plotted line associated with Time_'X' (and all of its analysis) is dropped from the report if "X" is set to zero. Time_'X' can be set to an absolute value (for example, 4.8 minutes) or to a value which is offset from, or a fraction of, the envelope or mid line peaks. Please see the description for the defaults variable 'Arbitrary Time_'X' (Min.)' in Section 10.2.

The raw data file, consisting of all of the collected points from a data collection run is usually plotted unfiltered (but to scale) on the screen before the analysis begins. Starting with v4.00, MixSmart allows the user to pre-filter the data in order to tame the fuzzier curves which are symptomatic of strain gauge collection systems. This optional procedure is controlled using the default variables 'Pre-Filter' and 'No. Stages' found on the General Analysis Control Menu and described in Section 10.2. As with all of the MixSmart filtering options, setting the number of stages to zero disables the filter. It is recommended that this option be left disabled until experience and specific circumstances suggest its use. When active, the midline and envelope analyses use the pre-filtered curve as their source.

The few users who had inserted an analog low-pass filtering system between the Mixograph sensor and the 'Black Box' will find that this software-only method is a preferable alternative.

13.2 Mid Line Analysis

These routines begin by smoothing the raw data using the software equivalent of a multi-stage low pass filter. Theoretically, a small filter value, using several stages, tracks the curve better at the cost of slightly higher processing time. In simplest terms, increasing the Mid Curve Filter, and to a lesser extent the Mid Curve No. Stages, makes the curve smoother but flatter. Decreasing these defaults variables makes the curve rougher and more likely to trip up later analysis because of local peaks and valleys.

The suggested values for the Mid Curve (Filter=80 and No. Stages=2) are a good compromise between smoothing, responsiveness, and processing time. On faster computers, or where processing time is not an issue, a filter value of 60 and number of stages set to 4 will track many curves more accurately. Once filtered, the curve is placed on the screen through the center of the raw data already plotted.

The mid line curve is more tolerant of variations in filter parameters than the envelope curves. This is partially due to the envelope creating mechanism, but mostly because the envelope curves have more rapid rise and fall times. Since the filtering operation is basically a low pass filter, relatively fast rise times can be troublesome.

The filtering process just described is run on the entire data set, from time =0 to 'Total Run Time'. The peak and slope finding routines ignore the filtered data before 'Start Time' and also ignore the filtered data after 'Total Run Time' minus 'Delta End Time'. That is to say, the user may exclude from analysis regions at the beginning of a data collection and at the end. These zones may contain spurious noise or user gaffs which would otherwise mislead the analytical routines. Setting these variables (found on the General Analysis Control menu) to zero effectively disables clipping in that region. In any case, time values are always reported as true time (i.e. from zero).

After plotting the middle curve, the mid peak location (time and height) is determined. First the maximum value in the filtered data is found, then, using a sampling window centered around this maxima, a least-squares quadratic fit is generated from which the maxima's value and time are determined. The size of this sampling window is controlled by the variable 'Mid Peak Fit Window'. This value, expressed in percent of total run time, is the region, centered about the first guess peak time, that is used for the quadratic regression.

It is possible to override the initial mid line peak finding mechanism by graphically selecting a peak time as controlled by the 'Use Manual First Mid Peak' check box. This method, explained along with its enabling variable in

Section 10.4, may require setting the Mid Peak 'Peak Fit Window' to zero to disable the regression.

Once the mid line peak time is determined, two other times can be calculated. Left of peak (time) is set equal to the determined peak time minus the user specified, 'Delta Left of Peak'. A linear regression is performed about this point and the resulting slope is recorded along with the left of peak time and value in the mid line analysis report. Right of peak is determined identically by the addition of the user specified, 'Delta Right of Peak', to the previously determined mid peak time. For both the left and right of peak fits, the size of the regression fit window is controlled by the value of 'Mid Slope Window'.

Curve_Tail time is calculated as 'Total Run Time' minus 'Delta End Time'. For this analytical point, a linear regression is performed using a small section (5%) of the filtered data set, ending at Curve_Tail (time). This section also produces a slope and best-fit value which are placed in the mid line section of the report.

'Arbitrary Time_'X'' is a time of the user's choosing. Many people use '8.00' minutes because it was the traditional run-time for older, pre-computerization Mixographs. This analytical point provides information in the same manner as previous ones. The values are determined using a fit centered about this user chosen time. The filtered curve time, height (value), and slope are recorded in the report. It is possible to specify times which are absolute or relative to the middle or top curve peaks. Please refer to Section 10.2 for a full explanation.

The 'Integral' column on the report is a Simpson's numerical integral over the mid line curve from time = 0 to each time reported in the mid line analysis. This value can be directly related to the amount of work put into the dough in reaching the time in question. The mid line integrals section is one of the most reproducible parts of an analysis. It is also relatively immune to variations in filter settings.

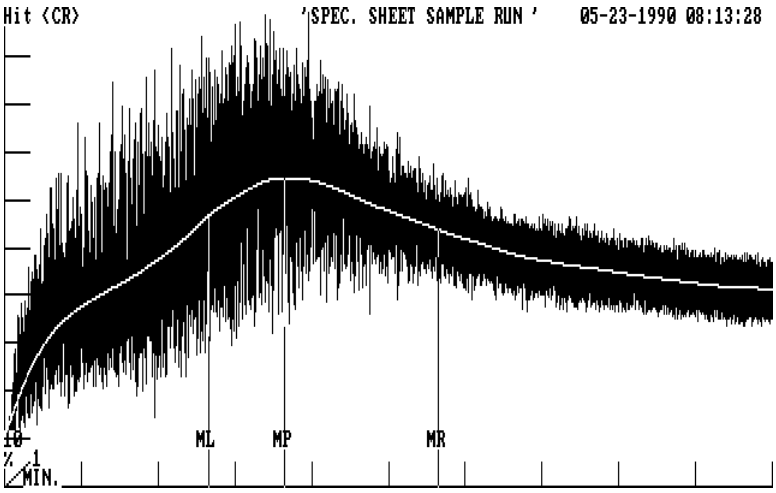
The remaining column in the mid line analysis, Width, is explained in Section 13.4, the combined analyses portion of this chapter.

The next three pages contain some mid line analysis examples. For the sake of clarity, the envelope and Time_'X' analyses have been disabled. The envelope analysis mechanisms, whose discussion follows these examples, are in part based on the filtering techniques demonstrated here.

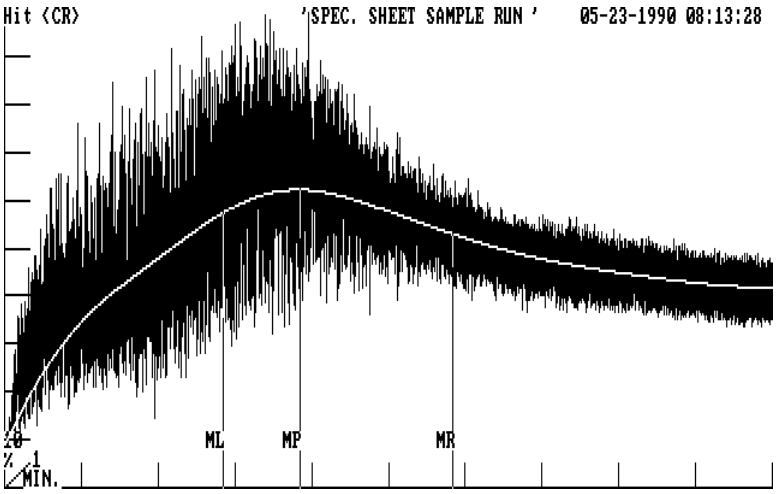
Testing the Filter Parameters

On Data File SAMPLE.MXG

Filter Value = 160
No. of Stages = 1



Filter Value = 160
No. of Stages = 4

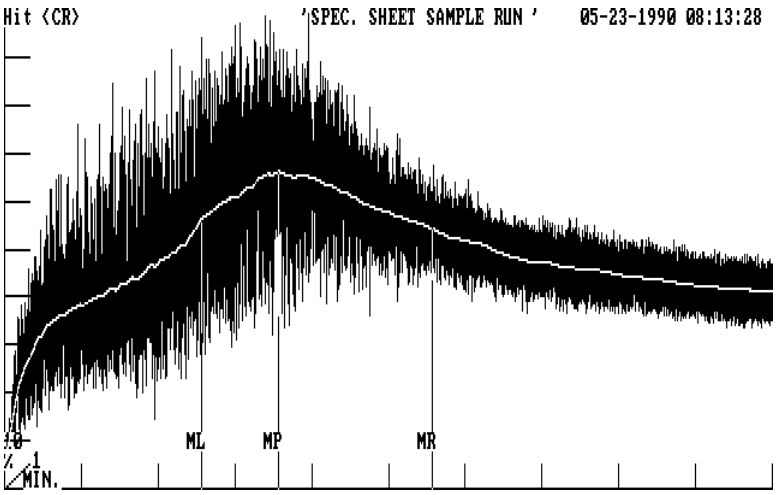


From these two examples it can be seen that, for medium sized filter values, increasing the number of stages produces only subtle effects. In this case the most obvious are a rounding of the peak and the disappearance of a visible swayback on the ascending side. Users accustomed to the 'look' of a mid line curve may assess the swayback on the left side of the top example (coupled with the early peak time) as indicative of too much absorption. For this reason, excessive filtering should be avoided as it can hide important properties.

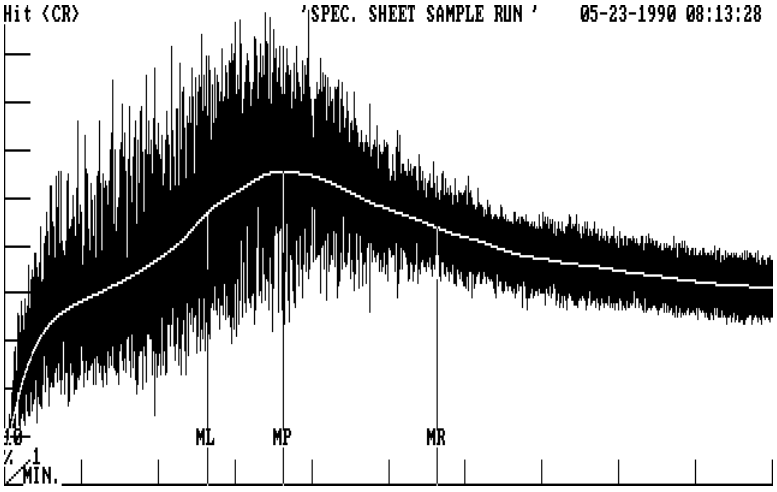
Testing the Filter Parameters

Using Data File SAMPLE.MXG

Filter Value = 40
No. of Stages = 1



Filter Value = 40
No. of Stages = 4

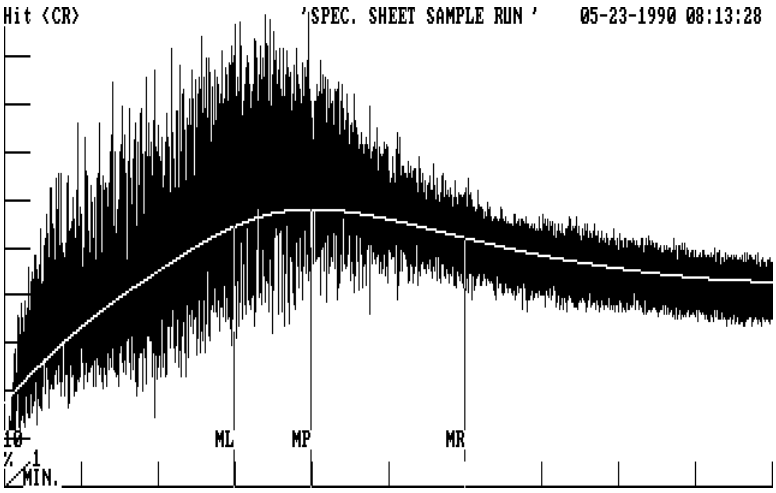


In this example the effects of multiple stages are quite apparent. In the first case the filter is obviously too weak, producing a rough and potentially misleading curve. By increasing the number of stages we effectively multiply the smoothing effect without flatting out as much detail as a higher filter value would. This second curve, in over all shape, closely resembles the first sample on the previous page. The main differences being a slightly greater, perhaps meaningful, articulation displayed-- especially in the sway back region before the peak; and a sharper, better-defined peak. Note, also, that in these cases the product of the filter value and the number of stages is the same value. Maintaining a constant product is a useful guide when adjusting the filtering systems for subtle smoothing affects as opposed to gross shape changes.

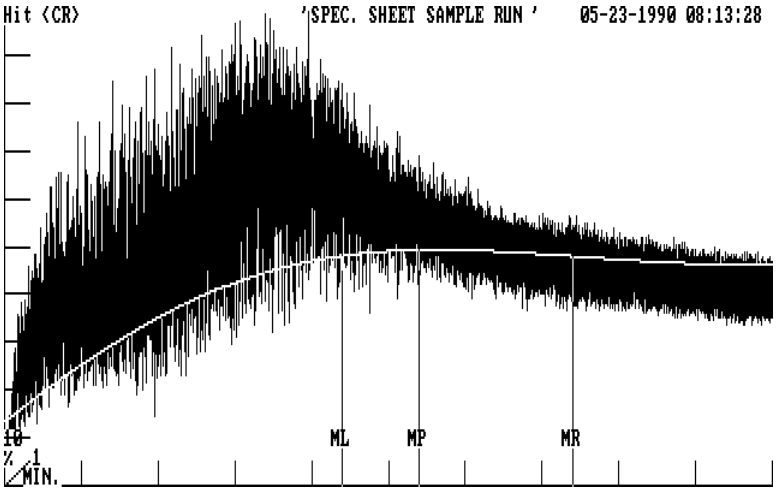
Testing the Filter Parameters

Using the Data File SAMPLE.MXG

Filter Value = 640
No. of Stages = 1



Filter Value = 640
No. of Stages = 4



From these two examples it is plain that the filter value chosen is much too large. The low pass time constant implied by a value of 640 is much too long for the features we are interested in. In the second curve, using this filter in multiple passes emphasizes the point.

From the last three pages it can be concluded that lower filter values with more stages, though computationally slower, are generally better, while very high filter values track the curve poorly.

13.3 Envelope Analysis

The work in this section actually involves constructing two curves. The top of envelope curve is used for most of the analytical work while the bottom of envelope curve is used in conjunction with the top only to calculate the width and area data.

Previous versions of MixSmart offered two techniques for generating separate top and bottom edge-hugging traces. The older technique, called the Asymmetric Filter approach, has been discontinued as it was problematic with steeper curves and was also more difficult to defend numerically. The second envelope generation technique, called the Windowed Edge Tracker, is the one still used. This method uses a local maxima, local minima mechanism to more closely track rapid changes in the envelope shape at the expense of a slightly noisier curve. The Windowed Edge Tracker is controlled by the two variables, 'Top Finder Window' and 'Bottom Finder Window'.

Very flat peaks are known to cause regression convergence problems with the Windowed Edge Tracker as it leaves more perturbations in the unfiltered data. Also, this enveloping technique will produce slightly narrower envelopes as the sampling frequency goes down and may hug the very edges of the mixogram as the sampling frequency goes up. This last problem, however, can be addressed by increasing the top and bottom finder windows (typically they are set to .7 seconds, each).

Once the unfiltered top and bottom curves are generated, the regular low pass filtering functions are applied, possibly using different filter and number of stages values for the top and bottom curves. These variables ('Top Filter' , 'Bottom Filter' and their respective 'No. Stages') are described in Section 10.3, but they work on the very same principles listed for the filter and stage variables in the mid line analysis discussion.

One encouraging feature of the analytic techniques used is that above a certain threshold, they are relatively unaffected by sampling frequency. With some filter scaling adjustments, virtually identical results can be obtained from 50 sample/sec and 10 sample/sec versions of the same run. This saves data storage space and accelerates analysis. An older statistical study of the effects of sampling frequency can be found in Chapter 15.)

After generating and filtering the top and bottom envelope curves, the actual analysis begins by finding peak information on the top curve in the same manner as in the mid line analysis. The Envelope analysis procedures use 'Top Peak Window' and 'Use Manual First Top Peak.'

Once the peak data has been determined and recorded in the report, the peak time is used to break the filtered data into two parts for the analysis of 'left of peak' and 'right of peak'. In mathematical terms, the time chosen for left of peak in the top envelope curve analysis is that of the inflection point with maximum slope over the time from 'Analysis Start Time' to envelope peak time. If the top envelope curve has no inflection point (i.e. the second derivative is never zero), the left of peak index is chosen as the point whose second derivative's absolute value is closest to zero.

Having determined this time index, a linear regression fit over a narrow region (+/- 2.5% of runtime) provides the slope and value. These three numbers are put into the analysis report for left of peak in the envelope section. A tangent line representing this linear regression is also plotted on the graph.

The right of peak slope time is more complicated, but begins by finding the first inflection point in the top line curve data after the already determined envelope peak time. Since a peak always has a negative second derivative and a 'decaying tail' will always have a positive second derivative, the zero point must exist. A tangent line is created about this zero and plotted on the graph. This line is intersected with the Curve_Tail tangent line (explained next) to produce the recorded envelope right of peak time. This is the point about which the envelope right of peak values are determined.

The envelope curve tail analysis is performed identically to the mid line curve tail analysis except that the tangent line is also plotted.

The slopes and inflection points mentioned here are generated using a time windowing technique. The size of this window, and thus the results' immunity to perturbation in the filtered curve, is controlled by 'Envelope Slope Window'. Typically set to 7.5% of run time, this value can be increased to improve slope fit on top curves with relatively flat ascending (left of peak) and descending (right of peak) regions and decreased for curves with a severe ascending sway back. It is, however, generally better to check the choices for filter value and number of stages before changing this variable.

The analytical method applied to the envelope may seem a bit confusing at first, but it is actually a good approximation to a trained analyst's actions when a ruler is laid along the top of a Mixograph curve.

After completing the top curve analysis, the envelope bottom curve is used to calculate both midline and envelope widths. This is accomplished by evaluating the filtered bottom curve (no regressions performed) at each of the times used in the top midline curves and reporting the difference in the two values. Finally, the top and bottom curves are used to report the envelope area values which are bounded by time=0 (not the 'Analysis Start Time'), the time

index in question (for example, Peak Time), the top filtered curve, and the bottom filtered curve.

The following pages show the effects of different Top Finder and Bottom Finder windows. For the sake of clarity, the mid line and Time_'X' analyses have been disabled. Also, if not explicitly mentioned, the filter values and number of stages are kept constant at 160 and 1, respectively, and 'Envelope Slope Window' is set to 7.5%. Remember, however, that the effect of changing these numbers, discussed in the previous section, applies to the envelope curves as well as to the mid line curves.

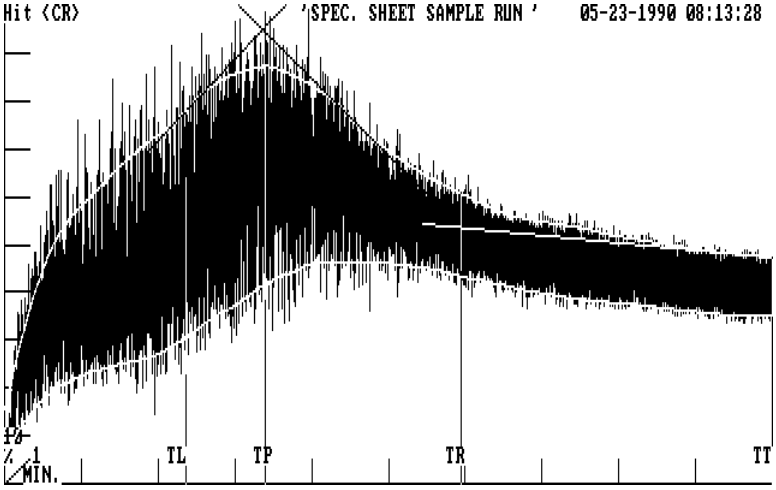
Testing the Windowed Edge Tracker Parameters

Using Data File SAMPLE.MXG

Top Finder... = 1 sec.
Bottom Finder... = 1 sec.

Top Filter Value = 160
Top No. of Stages = 1

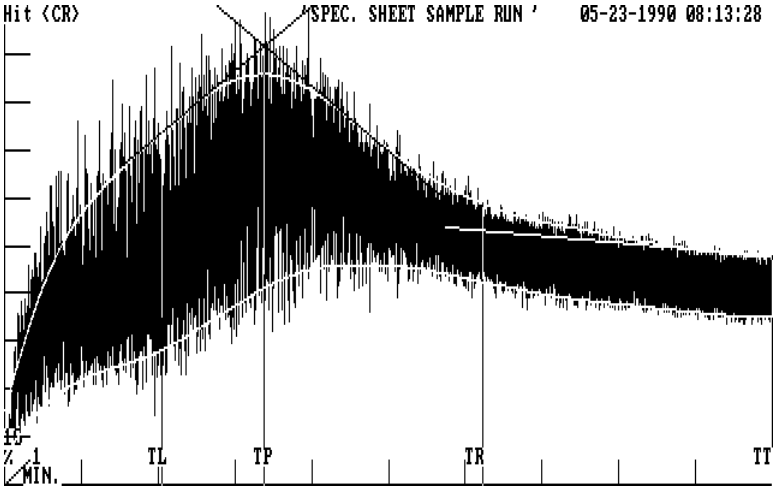
Bottom Filter Value = 160
Bottom No. of Stages = 1



Top Finder... = 1 sec.
Bottom Finder... = 1 sec.

Top Filter Value = 160
Top No. of Stages = 2

Bottom Filter Value = 160
Bottom No. of Stages = 2

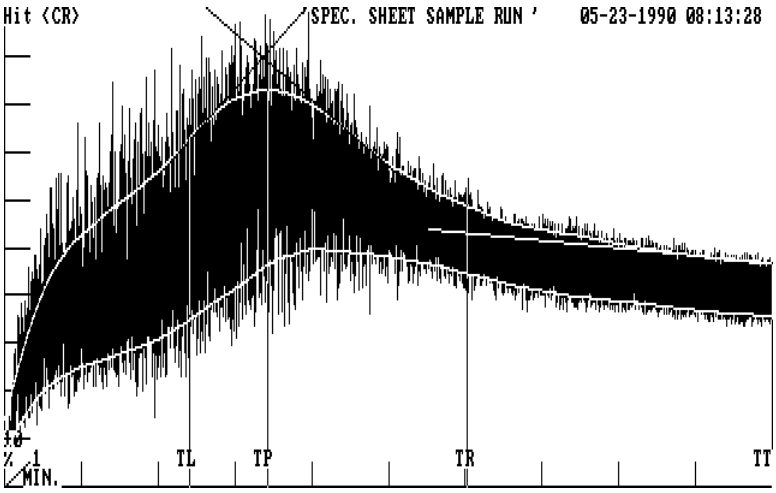


Using the suggested defaults for the Top and Bottom Finder Windows, the resulting envelope is quite acceptable, but slightly noisy as indicated by the poor left of peak tangent line. In the second envelope example only, the number of filter stages was increased producing a slight improvement in the left of peak tangent line.

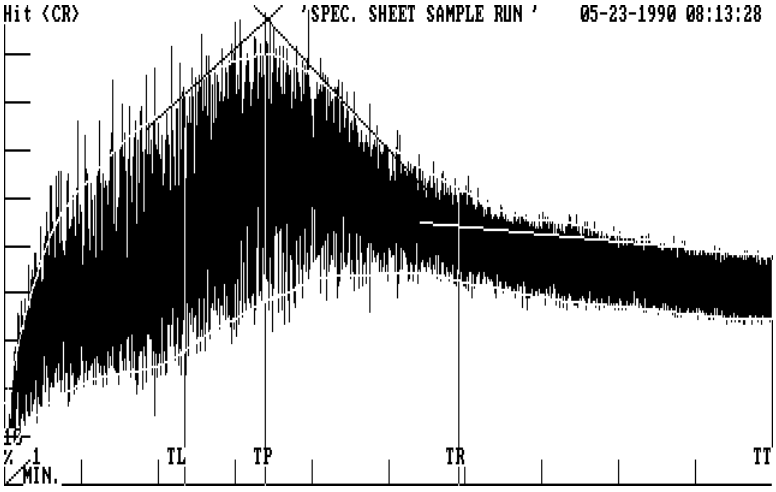
Testing the Windowed Edge Tracker Parameters

Using Data File SAMPLE.MXG

Top Finder... = .5 sec.
Bottom Finder... = .5 sec.



Top Finder... = 2 sec.
Bottom Finder... = 2 sec.



Both of these curves were run using low pass filter parameters of 160 by one stage. The larger finder window, however, requires stronger filtering. As the previous page suggests, using a two-stage filter would be adequate. From these two graphs, the actual effects of varying the Top and Bottom Finder windows are quite obvious. Increasing the window values floats the curves away from the center and decreasing them brings the curves slightly closer. This variation is especially noticeable on the more dynamic sections of the curve.

13.4 Combined Analyses

Some of the results in a particular section of the report form actually require data drawn from another section. This page describes such cases.

The Width column is the difference in the values for top of envelope and bottom of envelope at a particular time. These numbers are calculated from the filtered envelope curves, but as width is also reported for mid line times, the mid line section must borrow information from the envelope as well. Previous versions of MixSmart could not provide width or area analysis data if envelope analysis was disabled. Starting with DOS v4.00, however, the envelope and midline filtered curves are always created even if they will not be plotted or explicitly analyzed in the report. For this reason, area and width values and the curves which provide them are always available internally and to .PGM modules.

The Time_'X' report data can be made relative to the envelope peak, the mid line peak, or independent of either. Specifying a Time_'X' value relative to a disabled analysis will cause the information to be dropped from the report.

In part because the area column of the envelope analysis has been updated to resemble it, The Envelope Area Analysis feature has been removed from MixSmart. However, as a demonstration of the versatility of the programmable extensions to MixSmart it has been synthesized as a .PGM module included with the standard MixSmart package. See Section 18.1 for details.

Please note that Curve_Tail (time) and Time_'X' (time), are the same for both mid line and envelope analyses. The width column, therefore, holds identical results for these two sections.

Chapter 14

Comparing 35, 10 and 2 gram Mixographs

There may be slight differences between any two Mixographs, operators, or laboratory locations. In general, however, flour samples will be ranked in the same order. Likewise, computerization approaches may produce slightly different curve shapes or absolute values such as times or curve heights.

The next page contains a side-by-side comparison of two mixogram traces obtained simultaneously from the very same run of a moving bowl machine.

Following this are several pages containing examples of the same flour and absorption analyzed by the following instrument/interface combinations:

35g with strain gauge system
10g with strain gauge system
10g moving bowl
2g direct drive Prototype (pre-production model)

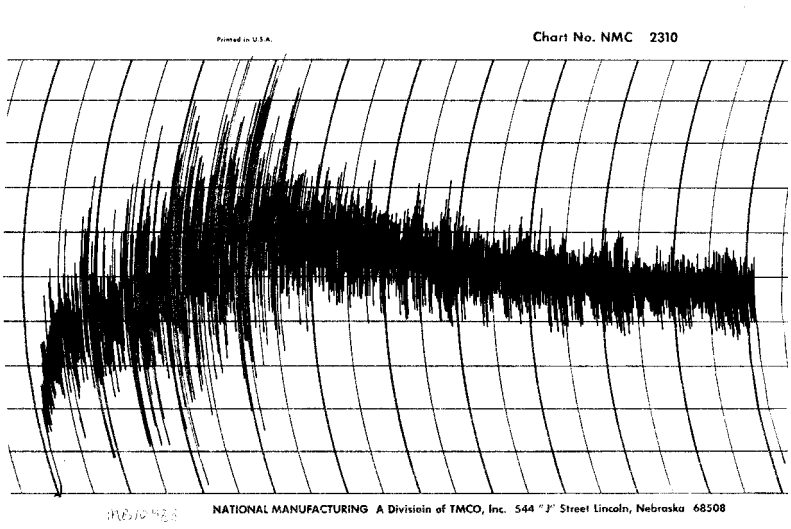
No formal statistics are presented, but from studying the accompanying reports it can be seen that the variations in results due to data acquisition techniques are not much greater than what would be expected from laboratory sampling techniques. The one exception to this statement might be the envelope width values. Wider and more variable bandwidths are known to be caused by the strain gauge electronics' greater sensitivity to narrow torque spikes which are normally dampened by the mechanical inertia of a moving arm.

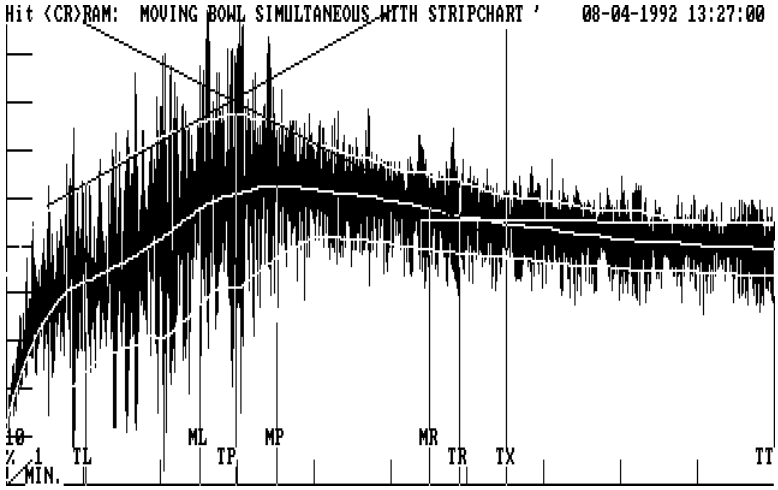
Note

This chapter predates (DOS) MixSmart v4.00 and, as in most of the early work, depends on the 'Asymmetric Filter' numerical method to extract the envelope (i.e. upper and lower) curves. However, the current envelope extraction method (Windowed Edge Tracker) was chosen in replacement as it overall provides a better match to real world data. Finally, the older versions of MixSmart did not support the 'Pre-Filter' option which can be used to greatly reduce the excessive bandwidths produced by some strain gauge and direct drive interfaced instruments.

Comparing the Old and the New

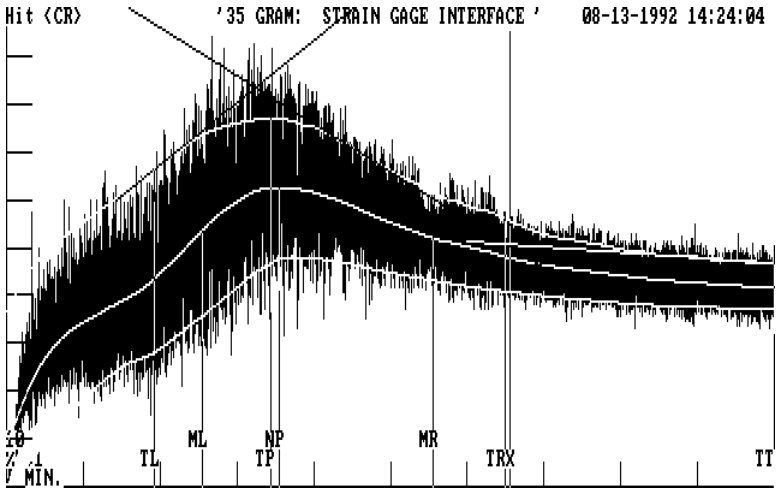
Traces Recorded Simultaneously by Strip Chart and Moving Bowl Transducer





From these images it is plain that no information has been lost in moving to the electronic medium. In fact, about ten times more detail is stored in the MXG file than can be obtained from visual inspection of the curvilinear trace.

35 Gram With Strain Gauge Interface



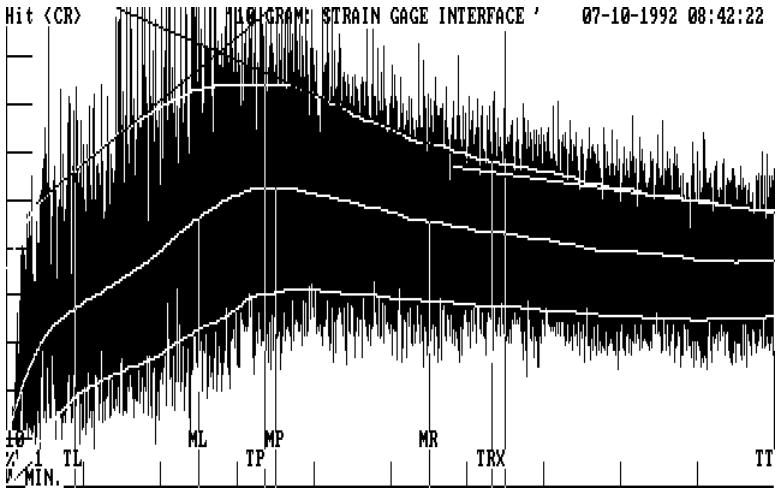
35 GRAM: STRAIN GAUGE INTERFACE

35GSG.MXG 08-13-1992 14:24:04 Analyzed: 08-21-1992 23:56:53

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Mid Curve Filter	160	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	2.00
Minimum Plot Value	2091	Maximum Plot Value	2692
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.00
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	160	Top Curve No. Stages	1
Bottom Curve Filter	160	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	MP+3.0	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	1.93	66.4	12.93	38.3	
PEAK	3.44	76.8	=0=	30.2	
RIGHT_OF_PEAK	6.49	56.0	-10.08	15.0	
CURVE_TAIL	10.00	46.5	-1.22	9.6	
TIME_'X'	6.55	55.6	-7.05	14.8	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	2.55	53.4	16.20	37.9	90.7
PEAK	3.55	62.6	=0=	29.0	150.1
RIGHT_OF_PEAK	5.55	52.0	-4.97	18.1	265.9
CURVE_TAIL	10.00	41.6	-0.97	9.6	467.7
TIME_'X'	6.55	47.9	-4.15	14.8	315.9

10 Gram With Strain Gauge Interface



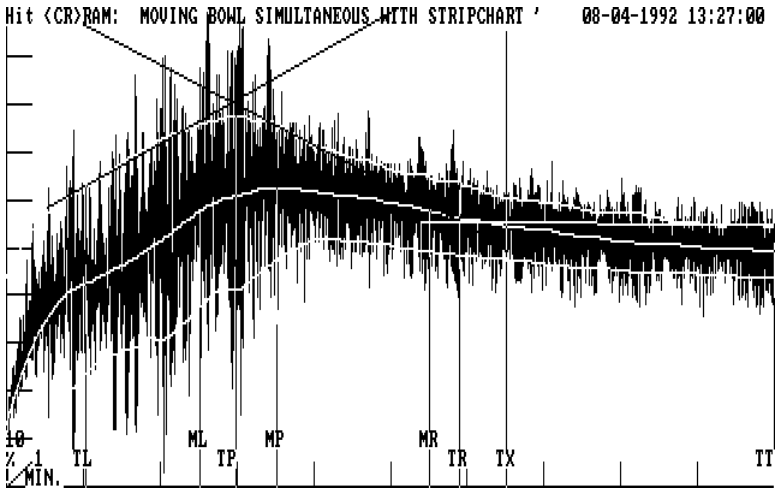
10 GRAM: STRAIN GAUGE INTERFACE

10GSG.MXG 07-10-1992 08:42:22 Analyzed: 08-22-1992 00:00:06

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Mid Curve Filter	160	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	2.00
Minimum Plot Value	29	Maximum Plot Value	306
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.00
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	160	Top Curve No. Stages	1
Bottom Curve Filter	160	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	MP+3.0	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	0.89	66.1	13.29	47.3	
PEAK	3.36	84.1	=0=	44.0	
RIGHT_OF_PEAK	6.33	67.9	-7.01	30.0	
CURVE_TAIL	10.00	57.4	-2.24	21.7	
TIME_'X'	6.50	67.3	-3.13	29.6	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	2.50	56.1	11.61	50.2	98.7
PEAK	3.50	62.5	=0=	43.0	159.1
RIGHT_OF_PEAK	5.50	55.4	-2.04	33.2	277.5
CURVE_TAIL	10.00	47.3	-0.00	21.7	503.4
TIME_'X'	6.50	52.8	-1.76	29.6	331.5

10 Gram With Moving Bowl Interface



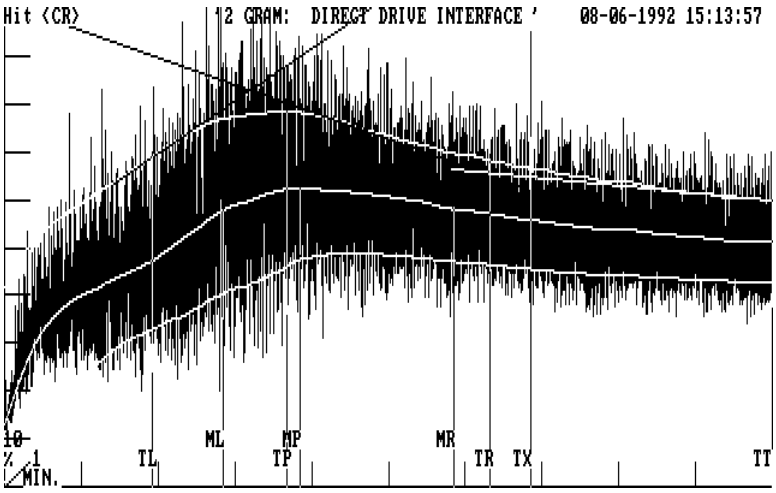
10 GRAM: MOVING BOWL SIMULTANEOUS WITH STRIPCHART

10GMB.MXG 08-04-1992 13:27:00 Analyzed: 08-21-1992 22:48:45

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Mid Curve Filter	160	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	2.00
Minimum Plot Value	137	Maximum Plot Value	475
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.00
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	160	Top Curve No. Stages	1
Bottom Curve Filter	160	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	MP+3.0	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	1.03	62.7	9.15	39.1	
PEAK	2.99	77.4	=0=	36.0	
RIGHT_OF_PEAK	5.90	63.3	-8.42	15.0	
CURVE_TAIL	10.00	54.6	-0.20	11.1	
TIME_'X'	6.51	60.4	-3.47	12.7	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	2.52	57.4	10.43	38.2	106.6
PEAK	3.52	62.5	=0=	28.4	167.3
RIGHT_OF_PEAK	5.51	57.6	-3.98	15.4	288.2
CURVE_TAIL	10.00	49.3	-0.86	11.1	523.1
TIME_'X'	6.51	54.5	-2.13	12.7	344.0

2 Gram Direct Drive Prototype



2 GRAM: DIRECT DRIVE INTERFACE

2GDDRV.MXG 08-06-1992 15:13:57 Analyzed: 08-22-1992 00:02:15

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Mid Curve Filter	160	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	2.00
Minimum Plot Value	2110	Maximum Plot Value	3490
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.00
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	160	Top Curve No. Stages	1
Bottom Curve Filter	160	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	MP+3.0	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	1.92	69.0	10.95	36.1	
PEAK	3.68	78.4	=0=	32.4	
RIGHT_OF_PEAK	6.32	68.2	-5.62	21.8	
CURVE_TAIL	10.00	59.8	-1.51	17.0	
TIME_'X'	6.85	66.5	-1.61	21.1	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	2.85	57.5	8.47	36.5	119.0
PEAK	3.85	62.5	=0=	30.8	179.5
RIGHT_OF_PEAK	5.85	58.1	-2.30	22.7	300.9
CURVE_TAIL	10.00	51.0	-1.02	17.0	525.2
TIME_'X'	6.85	55.8	-1.91	21.1	357.8

Chapter 15

Sampling Frequency Effect

Some workers have felt that the sampling frequency needed to be quite high to get good results from their data analysis. Indeed, low sample rates yield a curve that appears to be quite erratic and difficult to interpret. That was especially true if the mathematical smoothing technique was based upon blocks containing a fixed number of data points. The software approach described in this book is relatively independent of the sampling frequency, and it smoothes over a time-weighted window.

To illustrate this program's data analysis routine's relative insensitivity to sampling frequency, a data run was collected at 50 Hz for 10 min (30,000 points, the maximum allowable prior to MixSmart For Windows). The files were then "stripped" by systematically removing some data points. For example, every other point was kept, reducing the effective sampling frequency to 25 Hz. Likewise, only every fifth point was saved, reducing the effective sampling frequency to 10 Hz, and so on until only every 1/50 point was saved, for an effective 1 Hz sampling rate.

While the graphics displays (figures on following pages) appear to change substantially at 5 Hz and lower, in fact, the mathematically derived curve parameters change very little. Even all the way down to 1 Hz and 2 Hz the differences between frequencies are far less than the random error between replicate analyses. The areas beneath the mid line (analogous to work input) are phenomenally similar. Only the "slopes" vary. See the summarized data tables on the next two pages.

Therefore, the high sample rates (50 Hz and above) used by some workers are completely unnecessary in the practical application of the Mixograph. (The higher frequencies, especially correlated with Mixograph pin position, however, may have some theoretical interest as more is learned about <u>how</u> doughs develop.) The higher rates do drastically increase the disk storage required, and simultaneously slow down the analysis calculations.

We have found that 10 Hz is a good sampling rate. The data file is small enough to be analyzed quickly, yet not lose information, or give the wrong results.

Users who want to collect at higher rates in spite of this study, or perhaps because of it, are reminded that the standard ADCComm interface box

supplied with the software normally filters out all sampling artifacts above 25 Hz. National Mfg. can provide a modified version of this interface which permits sampling at up to 125 Hz. However, the user should realize that the necessary reduction in signal filtration will greatly increase the baseline noise.

Note

The reports in this chapter predate (DOS) MixSmart v4.00 and, as in most of the early work, depend on the Asymmetric Filter numerical method to extract envelope (i.e. upper and lower) curves. The current envelope extraction technique (Windowed Edge Tracker) is more robust over all but is somewhat more sensitive to sampling frequency. Also, in an effort to remove some of the 'black magic' from the analytical routines, MixSmart no longer attempts to frequency compensate the user supplied filter values during the actual data analysis. Most users will employ only the recommended sampling frequency of 10hz, which was the normalized value used in the old filter compensation scheme. At this setting, the midline and envelope results compared here would change very little under the newer curve generating and filtering methods. At higher or lower sampling rates, however, some adjustment of the filter values may be required to give interchangeable results. Once again, most people will use only the default sampling frequency and those who do need to run at a different rate will probably work at that new rate for some time after a methods testing period.

Sampling Frequency Effect

Mid Line

Summary

Frequency, Hz:	50	25	10	5	2	1	Mean	Std Dev	Cf Var
Left of Peak									
Time	3.42	3.41	3.42	3.42	3.44	3.43	3.42	0.01	0.28
Value	55.20	55.20	55.20	55.20	55.40	55.40	55.27	0.09	0.17
Slope	15.05	15.09	15.05	15.05	13.81	16.08	15.02	0.66	4.38
Width	36.30	36.50	36.70	36.70	38.40	40.10	37.45	1.37	3.66
Area	128.30	128.00	128.50	128.50	128.80	126.50	128.10	0.75	0.59
Peak									
Time	4.42	4.41	4.42	4.42	4.44	4.43	4.42	0.01	0.21
Value	64.20	64.20	64.20	64.20	65.10	66.60	64.75	0.89	1.37
Slope	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Width	29.60	29.60	29.80	29.80	30.90	31.30	30.17	0.67	2.24
Area	189.30	188.90	189.50	189.50	190.00	188.40	189.27	0.51	0.27
Right of Peak									
Time	5.42	5.41	5.42	5.42	5.44	5.43	5.42	0.01	0.17
Value	58.60	58.60	58.50	58.50	58.40	58.90	58.58	0.16	0.27
Slope	-8.86	-8.87	-8.89	-8.89	-9.81	-9.72	-9.17	0.42	4.57
Width	22.70	22.80	22.70	22.70	22.50	22.80	22.70	0.19	0.44
Area	251.50	251.20	251.80	251.80	252.50	251.80	251.77	0.39	0.16
Curve Tail									
Time	9.50	9.50	9.50	9.50	9.50	9.50	9.50	0.00	0.00
Value	42.40	42.40	42.40	42.40	42.30	42.50	42.40	0.06	0.14
Slope	-2.12	-2.11	-2.13	-2.13	-2.24	-2.27	-2.17	0.06	2.93
Width	8.60	8.50	8.50	8.50	8.70	8.80	8.60	0.12	1.34
Area	448.90	448.90	448.90	448.90	448.00	448.90	448.75	0.34	0.07
Time 'X'									
Time	8.00	8.00	8.00	8.00	8.00	8.00	8.00	0.00	0.00
Value	45.70	45.70	45.80	45.80	45.80	45.90	45.78	0.07	0.15
Slope	-2.50	-2.51	-2.55	-2.55	-2.54	-2.75	-2.57	0.08	3.28
Width	10.50	10.50	10.50	10.50	10.90	11.20	10.68	0.27	2.56
Area	382.80	382.80	382.80	382.80	381.90	382.60	382.62	0.33	0.09

The last three columns in this table and in the table on the next page are simple statistics on the six pieces of data in each row. 'Mean' is the average of these numbers. 'Std Dev' is the standard deviation. 'Cf Var' is the coefficient of variance which is calculated as 100 times the standard deviation divided by the mean.

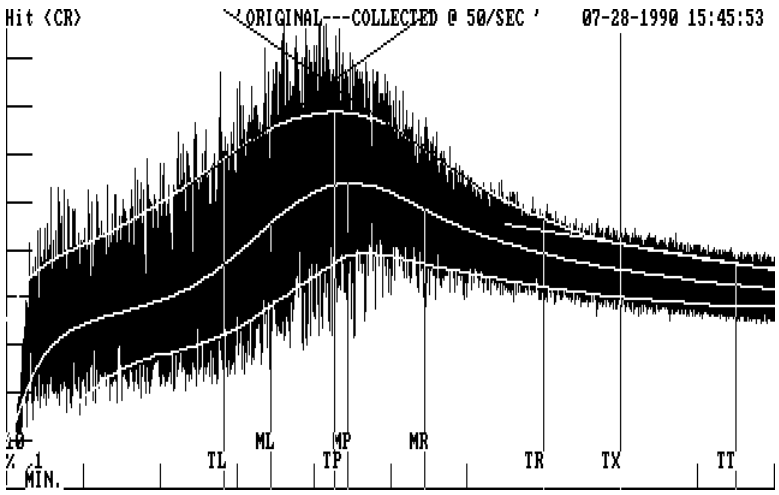
Sampling Frequency Effect

Envelope

Summary

Frequency, Hz:	50	25	10	5	2	1	Mean	Std Dev	Cf Var
Left of Peak									
Time	2.90	2.88	3.01	3.01	3.03	3.03	2.98	0.06	2.09
Value	68.60	68.40	70.00	70.00	70.70	71.10	69.80	1.08	1.43
Slope	13.12	13.12	12.35	12.35	13.90	16.22	13.51	1.32	9.79
Width	35.60	35.50	36.00	36.00	37.50	39.70	36.72	1.49	4.05
Peak									
Time	4.22	4.23	4.24	4.24	4.36	4.10	4.23	0.08	1.78
Value	79.10	79.10	79.20	79.20	80.30	81.90	79.80	1.03	1.29
Slope	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Width	31.90	31.70	31.80	31.80	30.90	31.40	31.58	0.34	1.09
Right of Peak									
Time	6.75	6.74	6.62	6.62	6.52	6.30	6.59	0.15	2.31
Value	57.00	57.10	57.90	57.90	58.70	60.40	58.17	1.15	1.97
Slope	-12.25	-12.18	-13.07	-13.07	-13.43	-14.73	-13.12	0.85	6.48
Width	13.70	13.80	14.30	14.30	14.80	16.00	14.48	0.77	5.31
Curve Tail									
Time	9.50	9.50	9.50	9.50	9.50	9.50	9.50	0.00	0.00
Value	46.80	46.70	46.70	46.70	46.70	46.70	46.72	0.04	0.08
Slope	-2.65	-2.72	-2.71	-2.71	-2.93	-3.44	-2.86	0.27	9.58
Width	8.60	8.50	8.50	8.50	8.70	8.80	8.60	0.12	1.34
Time 'X'									
Time	8.00	8.00	8.00	8.00	8.00	8.00	8.00	0.00	0.00
Value	50.80	50.80	50.80	50.80	50.90	51.40	50.92	0.22	0.43
Slope	-2.92	-2.81	-2.89	-2.89	-2.91	-3.20	-2.94	0.12	4.19
Width	10.50	10.50	10.50	10.50	10.90	11.20	10.68	0.27	2.56

Data as Collected (50 Hz)



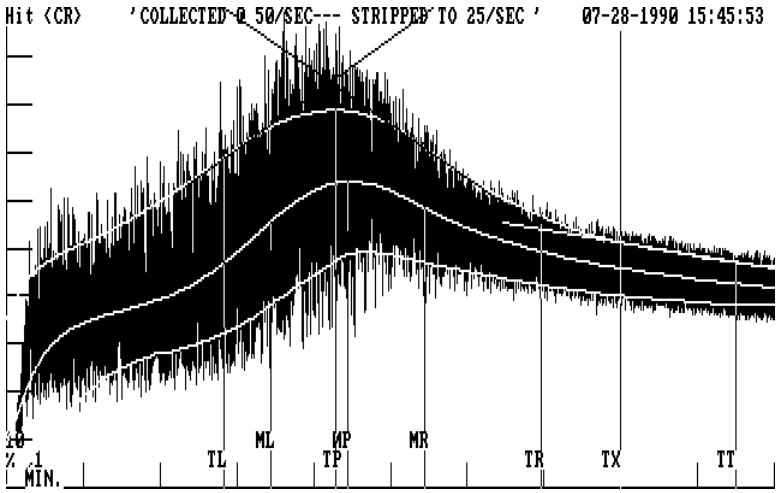
ORIGINAL---COLLECTED @ 50/SEC

50HZTEST.MXG 07-28-1990 15:45:53 Analyzed: 08-18-1992 22:46:53

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	50.000
Mid Curve Filter	120	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	1.00
Minimum Plot Value	2130	Maximum Plot Value	2664
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.50
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	120	Top Curve No. Stages	1
Bottom Curve Filter	120	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	8.00	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	2.90	68.6	13.12	35.6	
PEAK	4.22	79.1	=0=	31.9	
RIGHT_OF_PEAK	6.75	57.0	-12.25	13.7	
CURVE_TAIL	9.50	46.8	-2.65	8.6	
TIME_'X'	8.00	50.8	-2.92	10.5	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	3.42	55.2	15.05	36.3	128.3
PEAK	4.42	64.2	=0=	29.6	189.3
RIGHT_OF_PEAK	5.42	58.6	-8.86	22.7	251.5
CURVE_TAIL	9.50	42.4	-2.12	8.6	448.9
TIME_'X'	8.00	45.7	-2.50	10.5	382.8

Data Stripped to Emulate 25 Hz



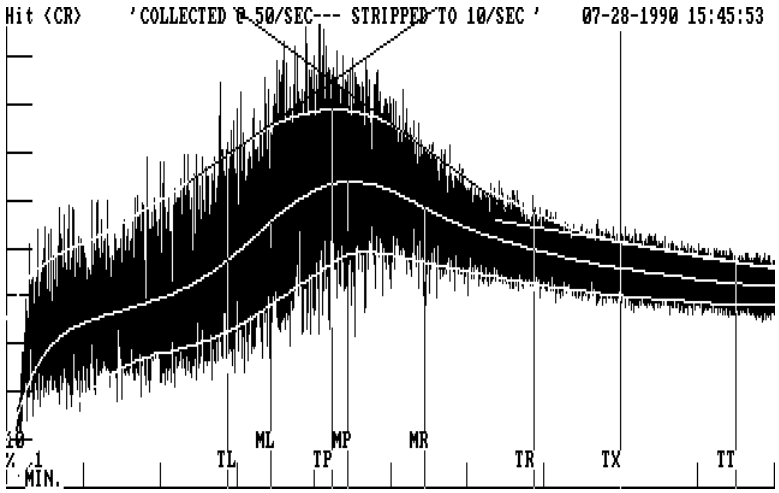
COLLECTED @ 50/SEC--- STRIPPED TO 25/SEC

50HZBY2.MXG 07-28-1990 15:45:53 Analyzed: 08-18-1992 22:42:57

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	25.000
Mid Curve Filter	120	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	1.00
Minimum Plot Value	2130	Maximum Plot Value	2664
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.50
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	120	Top Curve No. Stages	1
Bottom Curve Filter	120	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	8.00	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	2.88	68.4	13.12	35.5	
PEAK	4.23	79.1	=0=	31.7	
RIGHT_OF_PEAK	6.74	57.1	-12.18	13.8	
CURVE_TAIL	9.50	46.7	-2.72	8.5	
TIME_'X'	8.00	50.8	-2.81	10.5	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	3.41	55.2	15.09	36.5	128.0
PEAK	4.41	64.2	=0=	29.6	188.9
RIGHT_OF_PEAK	5.41	58.6	-8.87	22.8	251.2
CURVE_TAIL	9.50	42.4	-2.11	8.5	448.9
TIME_'X'	8.00	45.7	-2.51	10.5	382.8

Data Stripped to Emulate 10 Hz



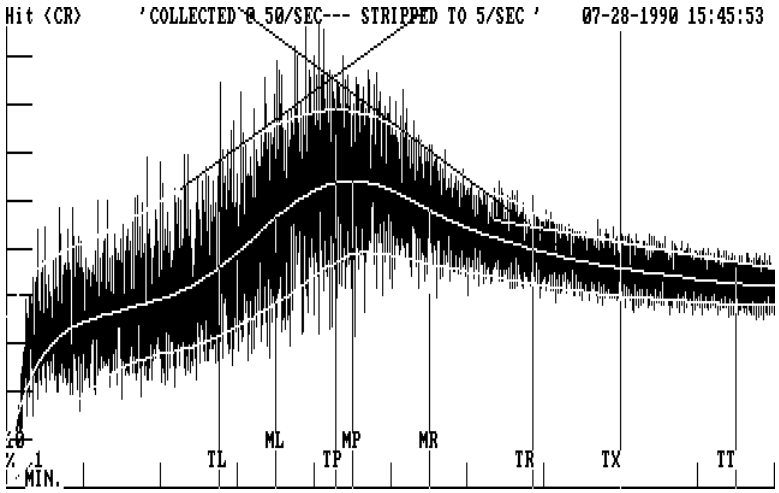
COLLECTED @ 50/SEC--- STRIPPED TO 10/SEC

50HZBY5.MXG 07-28-1990 15:45:53 Analyzed: 08-18-1992 22:43:41

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Mid Curve Filter	120	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	1.00
Minimum Plot Value	2130	Maximum Plot Value	2664
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.50
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	120	Top Curve No. Stages	1
Bottom Curve Filter	120	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	8.00	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	3.01	70.0	12.35	36.0	
PEAK	4.24	79.2	=0=	31.8	
RIGHT_OF_PEAK	6.62	57.9	-13.07	14.3	
CURVE_TAIL	9.50	46.7	-2.71	8.5	
TIME_'X'	8.00	50.8	-2.89	10.5	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	3.42	55.2	15.05	36.7	128.5
PEAK	4.42	64.2	=0=	29.8	189.5
RIGHT_OF_PEAK	5.42	58.5	-8.89	22.7	251.8
CURVE_TAIL	9.50	42.4	-2.13	8.5	448.9
TIME_'X'	8.00	45.8	-2.55	10.5	382.8

Data Stripped to Emulate 5 Hz



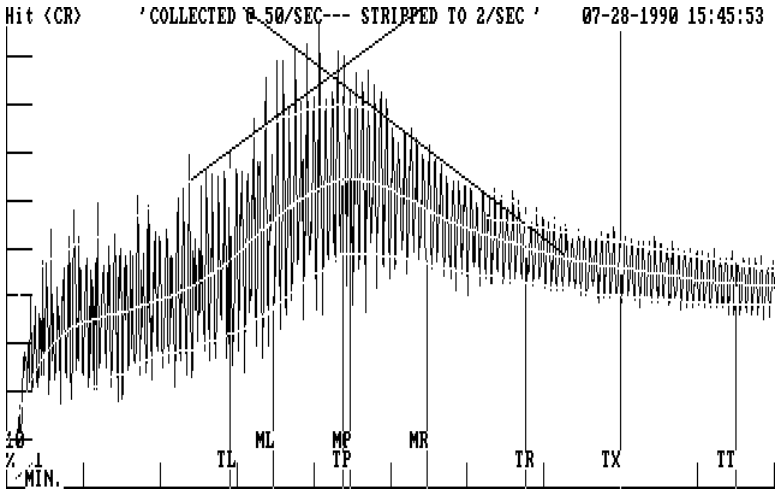
COLLECTED @ 50/SEC--- STRIPPED TO 10/SEC

50HZBY5.MXG 07-28-1990 15:45:53 Analyzed: 08-18-1992 22:43:41

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Mid Curve Filter	120	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	1.00
Minimum Plot Value	2130	Maximum Plot Value	2664
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.50
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	120	Top Curve No. Stages	1
Bottom Curve Filter	120	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	8.00	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	3.01	70.0	12.35	36.0	
PEAK	4.24	79.2	=0=	31.8	
RIGHT_OF_PEAK	6.62	57.9	-13.07	14.3	
CURVE_TAIL	9.50	46.7	-2.71	8.5	
TIME_'X'	8.00	50.8	-2.89	10.5	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	3.42	55.2	15.05	36.7	128.5
PEAK	4.42	64.2	=0=	29.8	189.5
RIGHT_OF_PEAK	5.42	58.5	-8.89	22.7	251.8
CURVE_TAIL	9.50	42.4	-2.13	8.5	448.9
TIME_'X'	8.00	45.8	-2.55	10.5	382.8

Data Stripped to Emulate 2 Hz



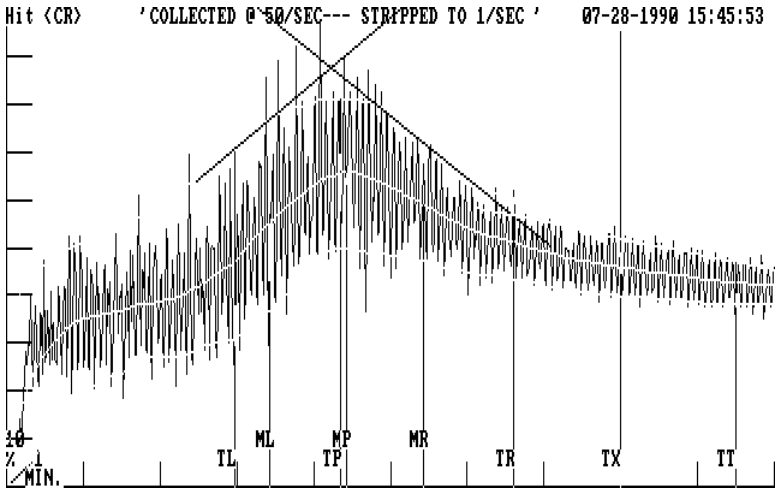
COLLECTED @ 50/SEC--- STRIPPED TO 2/SEC

50HZBY25.MXG 07-28-1990 15:45:53 Analyzed: 08-18-1992 22:43:35

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	2.000
Mid Curve Filter	120	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	1.00
Minimum Plot Value	2130	Maximum Plot Value	2664
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.50
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	120	Top Curve No. Stages	1
Bottom Curve Filter	120	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	8.00	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	3.03	70.7	13.90	37.5	
PEAK	4.36	80.3	=0=	30.9	
RIGHT_OF_PEAK	6.52	58.7	-13.43	14.8	
CURVE_TAIL	9.50	46.7	-2.93	8.7	
TIME_'X'	8.00	50.9	-2.91	10.9	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	3.44	55.4	13.81	38.4	128.8
PEAK	4.44	65.1	=0=	30.9	190.0
RIGHT_OF_PEAK	5.44	58.4	-9.81	22.5	252.5
CURVE_TAIL	9.50	42.3	-2.24	8.7	448.0
TIME_'X'	8.00	45.8	-2.54	10.9	381.9

Data Stripped to Emulate 1 Hz



COLLECTED @ 50/SEC--- STRIPPED TO 1/SEC

50HZBY50.MXG 07-28-1990 15:45:53 Analyzed: 08-18-1992 22:43:57

VARIABLE NAME	VALUE	VARIABLE NAME	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	1.000
Mid Curve Filter	120	Mid Curve No. Stages	1
Delta Left of Peak (Min.)	1.00	Delta Right Of Peak (Min.)	1.00
Minimum Plot Value	2130	Maximum Plot Value	2664
Analysis Start Time (Min.)	0.00	Delta End Time (Min.)	0.50
Filter Attack Rate	4.00	Filter Decay Rate	0.25
Top Curve Filter	120	Top Curve No. Stages	1
Bottom Curve Filter	120	Bottom Curve No. Stages	1
Arbitrary Time 'X' (Min.)	8.00	Slope Scanning Window (%)	7.5
Use Manual First Peak	No	Peak Fitting Window (%)	5.0

Title	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min.)
ENVELOPE ANALYSIS:					
LEFT_OF_PEAK	3.03	71.1	16.22	39.7	
PEAK	4.10	81.9	=0=	31.4	
RIGHT_OF_PEAK	6.30	60.4	-14.73	16.0	
CURVE_TAIL	9.50	46.7	-3.44	8.8	
TIME_'X'	8.00	51.4	-3.20	11.2	
MID LINE ANALYSIS:					
LEFT_OF_PEAK	3.43	55.4	16.08	40.1	126.5
PEAK	4.43	66.6	=0=	31.3	188.4
RIGHT_OF_PEAK	5.43	58.9	-9.72	22.8	251.8
CURVE_TAIL	9.50	42.5	-2.27	8.8	448.9
TIME_'X'	8.00	45.9	-2.75	11.2	382.6

Chapter 16

MixSmart Defaults Variables Index

16.1 The Standard Variables Set

The following chart of typical settings is a screen capture from 'View/Print All Preferences' under the Preferences menu. It is alphabetical based on the internal (.PGM/.MBF) variable name.

MixSmart Defaults Variables Report 06-18-2004
MIXSMART.INI

Variable Name	Description	Format	Value
Absorption	Absorption (%)		63.4
ADCChannel	ADC Channel	#	0
ADCCommPort	Communications Port	##	2
ADCSpan	ADC Span	#####	434
ADCZero	ADC Zero	#####	402
AnalysisStartTime	Analysis Start Time (Min.)	###.##	0.00
AnalyticalModule	Analytical Module	str	
AppendToOutputFile	Append to Report File	boo	False
ArbitraryTimeX	Arbitrary Time 'X' (Min.)	str	8
Ash	Ash (%)	##.###	0.670
AutoIncrName	Auto Incr. .MXG File Name	boo	True
AutoTriggerDelta	Auto-Trigger Delta	###	5
AutoZeroTorque	AutoZero Torque Before run	boo	False
BottomFilter	Bottom Curve Filter	###.###	80.000
BottomFinderWindow	Bottom Finder Window (Sec.	###.##	0.70
BottomStages	Bottom Curve No. Stages	###	2
BriefGraph	Include Brief Report on Gr	boo	False
CustomerSampleID	Sample/Alternate Customer	str	>>>>> test samplex
DataPath	Data File (.MXG) Path	str	>>>>> C:\MixSmart For Windows\Data
DeltaEndTime	Delta End Time	###.##	0.00
DeltaLeft	Delta Left of Peak (Min.)	###.##	1.00
DeltaRight	Delta Right of Peak	###.##	1.00
EnableEnvelopeAnalysis	Enable Envelope Analysis	boo	True
EnableMidLineAnalysis	Enable Mid Line Analysis	boo	True
EnableRTP	Enable RunTime Peak Finder	boo	False
EnableUserAnalysis	Enable User Analysis	boo	False
EnvelopeSlopeWindow	Envelope Slope Scanning Wi	###.##	5.00
ExportExtension	Export File Extension	str	.XLS
ExportPath	Export File Path	str	>>>>> C:\MixSmart For Windows\SpreadSheets
Frequency	Frequency (Samples/Sec)	###.###	10.000
INIVersion	<InternalVar>	str	MXGWINv100
LastBatchName	<InternalVar>	str	sample
LastDataName	<InternalVar>	str	SAMPLE
LastProgramName	<InternalVar>	str	MIDLINE
LastReportName	<InternalVar>	str	SAMPLE
LastTemplateName	<InternalVar>	str	Sample

MainShaftRPM	Main Shaft Rpm	###.##	88.00
MidFilter	Mid Curve Filter	###.###	80.000
MidManual	Use Manual First Mid Peak	boo	False
MidPeakWindow	Mid Peak Fit Window (%)	###.##	5.00
MidSlopeWindow	Mid Slope Scanning Window	###.##	7.50
MidStages	Mid Curve No. Stages	###	2
MixerType	Mixer Type	str	10g Moving
Moisture	Moisture (%)	##.###	12.500
OperatorName	Operator Name	str	Joe
OverWriteMissing	During Analysis Overwrite	boo	True
PackFlag	Save in Packed Format	boo	True
PenWidth	Plotting Pen Width	###	1
PictureToFile	Picture to File (.BMP)	boo	False
PictureToPrinter	Picture to Printer	boo	False
PreFilter	Pre-Analysis Filter	###.###	1.010
PreStages	Pre-Analysis No. Stages	###	0
PrinterName	Printer Name	str	LJ4000 PS
Protein	Protein (%)	##.###	12.000
ReportPath	Report Files (.RPT/.BMP) P	str	>>>>> C:\MixSmart For Windows\Reports
ReportToFile	Report to File	boo	True
ReportToPrinter	Report to Printer	boo	False
RunTime	Total Run Time (Min.)	####.##	10.00
RTPConfirmationDelay	RunTime Peak Confirmation	####.##	10.00
RTPEnvelopeFinder	RunTime Peak Envelope Find	####.#	1.0
RTPFilterReachBack	RunTime Peak Filter Reach-	####.##	20.00
RTPFilterValue	RunTime Peak Filter Value	####.###	160.000
RTPStartTime	RunTime Peak Starting Sear	####.##	0.50
RTPType	RunTime Peak Type	str	MidLine
SampleType	Sample Type	str	HDW
SamplingMethod	Sampling Method	str	Timer
ScatterPlot	Scatter-Plot Data	boo	False
SyncEdge	Synchronization Edge	str	Leading
SyncSamplesPerRev	Sync. Samples Per Revoluti	##.###	3.000
Title	Title	str	test run
TopFilter	Top Curve Filter	###.###	80.000
TopFinderWindow	Top Finder Window (Sec.)	###.##	0.70
TopManual	Use Manual First Top Peak	boo	False
TopPeakWindow	Top Peak Fit Window (%)	###.##	5.00
TopStages	Top Curve No. Stages	###	2
TorqueMaxStdReading	Torque Max. Std. Reading	#####	3982
TorqueMinStdReading	Torque Min. Std. Reading	#####	91
UserVar0	<Undefined>		
UserVar1	<Undefined>		
UserVar2	<Undefined>		
UserVar3	<Undefined>		
UserVar4	<Undefined>		
UserVar5	<Undefined>		
UserVar6	<Undefined>		
UserVar7	<Undefined>		
UserVar8	<Undefined>		
UserVar9	<Undefined>		
UseSharedCalibrations	Use Shared Calibrations	boo	True

Variable Name	Description	Format	Value

Note that certain variables (for example, LastDataName) are described as '<InternalVar>'. These entities are not edited directly by the user. They are usually assigned as a side effect of selecting or creating a file. LastDataName, for example, holds the name of the most recently loaded, saved, or edited .MXG data set. These variables are of some use inside .PGM modules and batch files.

Ten entries on this listing (USERVAR0 through USERVAR9) are noted as undefined. These variables are defined by active .PGM modules. For example, if 'EnvelopeArea.PGM' had been active at the time this report were produced, the first one would have instead been defined as:

```
UserVar0              Envelope Area Width (Minut ###.###     2.000
```

Users developing custom .PGM modules should note that the internal variable name for these entries does not change when they are redefined.

The data formats listed with the variables are defined here:

'####', '#.###', etc. describe standard numbers. In these two examples the first can be a four digit integer and the second a floating point number. Settings and analytical data are generally stored internally at full machine precision and formatted only when presented on a menu or a report.

str describes simple text strings. These are generally not restricted for length but editor field size, output field size, and common sense may impose limits.

Boo describes Boolean data. These values can be either 'True' or 'False'. Within the preferences editors this is usually represented by a checked box for 'True' and an unchecked one for 'False'. Within the .PGM system, 'True' and 'False' are defined constants.

Note

When 'UseSharedCalibrations' is set to True, certain variables listed here (ADCSpan, ADCZero, TorqueMinStdReading, and Torque MaxStdReading) are also recorded in another data file called 'Calibration.inf'. When 'Shared Calibrations' are in affect, a profile's own calibration settings, are automatically updated to reflect these global values at the time it is loaded. Any subsequent changes made to these elements of the loaded profile are written back to the 'Calibration.inf' file when the profile is saved. The purpose of this redundant storage is explained in section 10.6.

16.2 The Temporary Variables Set

None of the information in this section is likely to be of any importance to the average user. Advanced users developing .PGM modules will find some of it indispensable and some of it trivial.

The various attributes preserved with the .MXG files at data collection are also accessible to the .PGM modules. These variables are listed below. Note that they are undefined outside of their active context. For example, MXG.CollectionDate is not meaningful if a .MXG file is not actually in memory for analysis. This is not a problem when a .PGM module acts as an Add-in which runs at the end of standard data analysis. It is also possible, however, to use the .PGM system to load an existing .MXG file, modify its header or data, and resave it. The most advanced application of these variables is to use the .PGM functions to create and write a synthetic .MXG header structure and data set. In this manner, special analyses combining multiple data sets can also be built up.

The following variables are mostly self explanatory and are not further documented here. Also, most are effectively defined in the description of their equivalent entries on the .MXG header editor screen under the Utilities menu. Advanced users may call National Mfg. if any questions arise. The variable's type is listed after each name.

MXG.Filename	str
MXG.FileDate	str
MXG.FileTime	str
MXG.CollectionDate	str
MXG.CollectionTime	str
MXG.Title	str
MXG.Frequency	float
MXG.RunTime	float
MXG.NumPoints	integer
MXG.NumChannels	integer
MXG.DataType	str
MXG.MinStdReading	integer
MXG.MaxStdReading	integer
MXG.MinStdValue	float
MXG.MaxStdValue	float
MXG.MinPlot	float
MXG.MaxPlot	float
MXG.MinCutOutValue	unused
MXG.MaxCutOutValue	unused
MXG.Moisture	float
MXG.Protein	float

MXG.Ash	float
MXG.Absorption	float
MXG.OperatorName	str
MXG.MixerType	str
MXG.SamplingMethod	str
MXG.MainShaftRPM	float
MXG.SampleType	str
MXG.CustomerSampleID	str
MXG.PackFlag	boo

Chapter 17

MixSmart Programmer's Supplement

This chapter and the next provide additional information on creating customized enhancements to MixSmart.

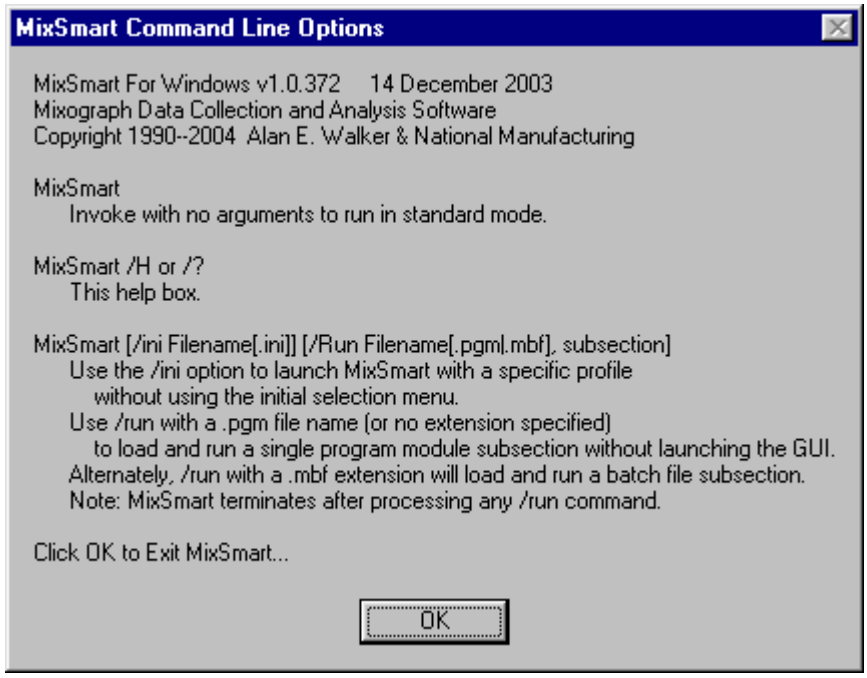
The .PGM extensions to MixSmart allow some customization of the analysis and reporting functions native to MixSmart and also allow creation of completely new analyses, which can be presented in the optional 'User' section of the standard analytical reports. The program modules (.PGM files) which generate these customizations can be provided by National Mfg., either as part of the library which ships with MixSmart (for example the EnvelopeArea.PGM file which is described in the next chapter), or as a custom developed module designed to meet a specific end user's requirements (see the note at the end of Chapter 8). End Users experienced in programming can, with the help of this documentation and the included examples, also develop their own custom analyses.

The following pages describe the general philosophy, syntax, and implementation details of the .PGM programming language. The user will also find the defaults variables listings in chapter 16 useful. The user may also refer to Chapter 8, which briefly describe the development and debugging utilities built into MixSmart.

General Overview of the MixSmart Programmer's Extensions
MixSmart versions 4.00 and later support a full procedural, extensible programming interpreter. This feature is tightly integrated into the package, allowing properly configured code modules to alter defaults variables, analyses, and reports as they run. Originally intended as a means of user specific customization of MixSmart's analytical engine, these new features have evolved to provide extensive control over plotting and reporting functions including, at the very least, the ability to create clear on-screen go/no-go assessments based on user's criteria for production environments. At the other end of the spectrum these new features allow very complex, research oriented, custom analysis and reporting on new or archival data sets, including comparative analysis between curves.

Enhanced Command Line Options for MixSmart
Intended mostly for testing, it is possible to load a defaults variables profile and execute a program module directly from the command line

avoiding all interactions with the menus. The following describes the capabilities of the command line:



The /RUN option is very sophisticated and allows the user to load and invoke a .PGM (Program Module) file block or a .MBF (MixSmart Batch File) file block directly from the command line without running through all the menus. If the /INI option is not also present, the user will be prompted to choose a profile, but otherwise no main program interaction is required. MixSmart exits after the invoked file completes its run.

Note

Any changes to the user profile during a command line /RUN event are NOT saved before MixSmart exits.

Since the batch file processor is now simply an extension of the .PGM system, it is possible to write full .PGM programs as batch files-- within which the user can load .MXG data files and invoke standard and custom data analyses.

For examples of typical program files, please see Chapter 18, which provides complete listings of two working .PGM add-ins and an analysis of a MixSmart data set using Fourier transforms.

For the listing of the STDINCL.LIB standard library module, please see Chapter 19.

Some example program modules are automatically copied to the MIXPGM directory of the installed MixSmart system. Additional modules are available on the installation diskette and can be copied into the running environment using the Setup program.

Error Trapping and Debugging

Errors encountered by the MixSmart PGM processor fall into two categories. In the first case, a missing file or a missing subsection will generate a 'file not found message box' before the parser is even started. Note that for a selected 'user module' invoked as a User's Analysis Add-in, the USER section must be present, even if it contains no code. The PRELOAD module is not required and will simply be ignored at program launch if not found.

Once the program parser begins running, most errors will terminate the analysis run and produce a possibly lengthy debug-style dump of the active program listing, dictionary, data stack, and execution stack. Errors in this class include, but are not limited to:

Data type mismatches (for example, using 'add' on a string)
Data range errors (for example, dividing by zero)
Performing a unary or larger operation on an empty data stack
Invoking an undefined procedure
Accessing an undefined variable

Many internal procedures also return error status as a Boolean on the top of the stack. It is the user's responsibility to react to these errors by either sending a message to the pending analytical report via the 'ERRLOGWRITE' function or taking some corrective action.

The remainder of this chapter is a full bestiary of all the internal functions and procedures available to .PGM modules.

Functions and Procedures Dictionary
For the MixSmart Programming Language

Keywords, user procedures, and variable names are not case sensitive, but string literals are.

; Comment. May begin anywhere in a line

/ /word → key
keyword entry (e.g. /bufptr becomes the keyword 'bufptr' (see 'DEF' for further explanation)

+- Unary signs (As the first character of a numeric constant)

.0123456789 numeric digits used to compose integer and floating point numeric constants

"" Double quote, used to mark beginning and end of string constant. String constants must close on the same line begun.

{} Open and close a deferred execution block. Can be spread over multiple lines

add num1 num2 ADD num1+num2
sum two numbers

addstr str1 str2 ADDSTR str1str2
concatenate two strings

analyzemxg handle ANALYZEMXG boo
Process the already loaded mxg data set.
Returns true on success, false on error.

and boo boo AND boo
logical andD operation

appendavifile
bmpname bmppath aviname avipath APPENDAVIFILE
Load BMP file and attach at end of an existing AVI file, updating all AVI header information.

arraycreate numpoints name ARRAYCREATE [newhandle]
'name' can be "" as arrays are usually addressed by handle.
Creates single dimensional extended memory array of numpoints elements, returning the new handle.
If process fails, an error is generated.

arrayinitall
maxelements ARRAYINITALL –
Discards all raw data arrays and creates a new handle allocation table with support for maxelements handles.

arrayread index handle ARRAYREAD num
Read single value from a raw data table.

arraysumread

index elementname handle ARRAYSUMREAD num
Read value from statistical sums table associated with a raw data set using index and the name of the statistical field (which is a string).
Use 'gensums' to add these tables to a standard data set.
The following cumulative sum elements are defined:

```
"scount"
"sx"
"sy"
"sx2"
"sy2"
"sxy"
"sx3"
"sx4"
"sx2y"
```

arraywrite val index handle ARRAYWRITE -
Write single value into data array

atn numerator denominator ATN arctangent(numerator/denominator)
Returns the 4 quadrant arctangent of the ratio of the Arguments. For example, 'sinang cosang ATN' returns the 0—360-degree angle whose sine and cosine values are passed to it. Both arguments cannot be zero.

blend coeffa coeffb const coeffab coeffadivb negmax posmax
srcAhandle srcBhandle desthandle BLEND
[desthandle] boo
Combine two data arrays using coefficients.
If desthandle is passed in as zero then
create new array for result and return the new handle. If desthandle is non-zero on invocation then write resulting array to desthandle (can be same as one of sources) and return no new handle.
IF srcAhandle=0 or srcBhandle=0 (i.e. a source does not Exist) then any dependent coefficients are assumed zero for those terms involving the zero handles.
The transform for each data cell is as follows:
(A= an element of source array 'srcAhandle'
(B= an element of source array 'srcBhandle')

Result = coeffa * A + coeffb * B + coeffab * A * B
+ coeffadivb * A/B

If a result is less than negmax it is set to negmax.
If a result is greater than posmax it is set to posmax.
If process fails, returns boo=FALSE and no new handle.

bmpload name path BMPLOAD
Load bmp picture into plotbox.

bmpwrite name path BMPWRITE
Write plotbox to BMP file.

chr num CHR str
converts ascii byte value to equivalent character

cleardict - CLEARDICT -
Erase all entries in dictionary, including simple vars, Procedures, and dictionary marks.

clearstack - ClEARSTACK -
Empties data stack.

cos num1 COS cos(num)
find cosine of degree argument

ctype any str CTYPE any
convert string on stack top to data type
and use to replace data type of next item.
Use the following string phrases:
"NUM"
"STR"
"KEY"
"BOO"

date - DATE str
Pushes current system date onto stack as string.

debug - DEBUG -
Opens debug window showing all current stacks, program pointers, etc...
User is allowed to continue program run afterward.

def key any DEF –
Local Define
Pops keyname and its definition from stack and stores it in the dictionary. If no match is found before hitting a 'dictmark' then assume is new definition and push onto top of dictionary stack.

delay num DELAY -
Delays nn seconds.

dft handle DFT REALhandle IMAGhandle
Generates full Discrete Fourier Transform
and returns real and imaginary arrays.

dftreverse REALhandle IMAGhandle DFTREVERSE REALhandle Imaghandle
Generates a full reverse DFT transform,
returning both real and imaginary parts.
In most cases, imaginary part is vestigal
and can be discarded.

discardhandle
handle DISCARDHANDLE -
Discards an array handle and its data if present,
returning it to 'free handles' list

div num1 num2 DIV num1/num2
Divides two numbers.

dup any DUP any any
Duplicates top entry in stack.

editgraphx startdex prompt EDITGRAPHX [enddex] boo
Allows user's graphical selection of time index.
Returned value (enddex) is scaled to x axis of plotbox.
Enddex is not returned on right-click or escape
which sets boo=FALSE. Startdex may usually be set to zero.

end - END -
Exits language processor by popping all exe entries off exe stack and clearing current exepointer.
Equivalent to '9999 popproc'.

eq, ne, lt, le, gt, ge num num EQ boo | nonnum nonnum EQ boo
Compare two numbers or two nonnumbers and return a Boolean.

errlogwrite
str ERRLOGWRITE -
Spools 'str' to text report's error log to be displayed at foot of report.

exch any1 any2 EXCH any2 any1
exchange top two stack items

exekey key EXEKEY keyval
Replaces key name on stack with its definition from Dictionary. Use this to fetch exe definition without executing it. For simple var defs, just invoke for same effect.

existdef key EXISTDEF boo
Looks for key in dictionary.
Returns TRUE if found.

existfile name$ path$ ext$ EXISTFILE boo
Confirms validity of filepathname.
Returns true if file present on specified path.
Returns false if file or path are absent or are invalid.
Note: ext$ of form .abc (period & 1-3 letters).

existpath path$ EXISTPATH boo
Returns True for valid, extant filepath.

exp num1 num2 EXP num1^num2
raise a number to a power

false - FALSE boo
Pushes Boolean constant, FALSE, onto stack.

filter size nstage period startdex enddex handle FILTER -
Applies a lowpass filter to a data array,
overwriting source array.

findminmax startdex enddex handle FINDMINMAX
mindex maxdex minval maxval
Searches index range of an array,
returning index and value of highest and lowest points.

fixfullpath partialpath FIXFULLPATH completepath$
Builds complete pathname from partial path and current drive and directory.

for numstart incrsize numend {proc} FOR
Execute proc while stepping through loop range.
Current step value is pushed onto stack before each proc Call.

format num fmtstr FORMAT formattednumber
Convert a number to string using supplied formatting string.
Using standard numeric only (##.## ... etc.) syntax.

gdef key any GDEF -
Global Define
Pop keyname and definition from stack and store in dictionary, ignoring any local dictionary marks if present.
If key not found in entire dictionary, then add as newest.

genarea handle GENAREA [areahandle] boo
Generate cumulative Simpson's integral for each point in source array, writing new table to created areahandle.
Returns boo=FALSE and no new handle if process fails.

genedge finderwindow edgetype srchandle GENEDGE edgehandle
find local max (edgetype=1) local min (edgetype=0) around each data point in srchandle
using window= index +/- finderwindow/2
Finderwindow is expressed as # of data points.
if calling routine is passing in 'seconds', multiply by frequency first.
Generate resulting 'filtered' data set and return as edgehandle.

genslopes scanwindow sumhandle GENSLOPES slope1handle slope2handle
Find local first and second order derivatives using full summary stats over fit window= index +/- scanwindow/2.
Scanwindow is expressed as percent of runtime.
Generate resulting data sets and return as handle pair.

gensums handle GENSUMS sumhandle boo
Add statitical summary tables to 'handle' data set.

getchar endlessflag GETCHAR returnedchar
If endlessflag=1 then wait for next keypress and return ASCII code.
If endlessflag=0 then return current/pending keypress or Zero if none pressed since last check
Special keyboard characters (like arrow keys) return 1000 + keyboard scan code

getdatasumhandle
name GETDATASUMHANDLE handle
locate datasumtbl handle by name and return handle value

getdirlist path ext GETDIRLIST filecount
Returns number of files found matching criteria 'Path*ext'
Returns 0 on none found or dir error.
NOTE ext of form .abc (period & 1-3 letters).

Getdirentry index GETDIRENTRY str
Returns 'index' file name in list generated by 'getdirlist'
Errors if index <1 or greater then ubound(dirlist)

getfreehandles
- GETFREEHANDLES handlecount
Returns number of unused handles available.

if boo {proc} IF -
Executes proc if boolean is true.

ifelse boo {proc1} {proc2} IFELSE
Executes first proc if boo is true, second if false.

include blockname filename INCLUDE -
Load 'blockname' subsection of 'filename' program (.PGM) file and resume execution at its beginning. Avoid placing this function inside any looping structure as repeated file load operations will slow execution.

index any num INDEX any stk(num)
copies 'n'th object from top of stack and pushes onto stack

initavifile bmpname bmppath aviname avipath framespersec INITAVIFILE
load bmp picture and use as template to create an empty AVI file. No image frames are actually written.

initgraphscreen
- INITGRAPHSCREEN -
Activates graphics screen for subsequent plotting or text display. It may still be necessary to set scaling.

instr str substr startdex INSTR founddex
Locates substr in str and returns its index (or zero if not found).

lcase str LCASE lcase(str)
Converts string to lower case.

len str LEN strsize
Returns length of string

linfitone startdex enddex handle LINFITONE [coeffx const] boo
Returns FALSE and no coefficients on failure
On success returns linear regression fit coefficients and TRUE. Note that this does not use any summary table as may already exist for an array. If a summary table already exists for such an array, use linfittbl as it runs faster.

linfittbl startdex enddex handle LINFITTBL [coeffx const] boo
Returns FALSE and no coefficients on failure
On success returns linear regression fit coefficients and TRUE. Note that handle array must include full stats summary table. If such a table does not exist for the raw data of interest, use linfitone or create the table with gensums.

loadmxg filename path extension channel LOADMXG handle
Load the mxg data set 'path\filename.extension'
and return handle to new, rescaled array.
Channel is normally '1', but can be used to retrieve other
data arrays if present in .MXG file.

log num LOG log(num)
Returns natural log of number.

ltrim srcstr strlist LTRIM substr
Removes all char(s) in strlist from left edge of a srcstr
and returns result.

mid str startdex len MID substr
Returns substr extracted from str starting at startdex
for a length of 'len' chars.

msgbox promptstr prompttype titlestr MSGBOX resultcode
User prompt with buttons.

Prompttype choices:
(choose one from each of 3 groups and sum)
(from vb 6.0 docs)

First Group:

0	Display OK button only.
1	Display OK and Cancel buttons.
2	Display Abort, Retry, and Ignore buttons.
3	Display Yes, No, and Cancel buttons.
4	Display Yes and No buttons.
5	Display Retry and Cancel buttons.
16	Display Critical Message icon.
32	Display Warning Query icon.
48	Display Warning Message icon.
64	Display Information Message icon.

Second Group:

0	First button is default.
256	Second button is default.
512	Third button is default.
768	Fourth button is default.

Third Group:

0	Application modal; the user must respond to the message box before continuing work in the current application.
4096	System modal; all applications are suspended until the user responds to the message box.
16384	Adds Help button to the message box.
65536	Specifies the message box window as the foreground window.
524288	Text is right aligned.
1048576	Specifies text should appear as right-to-left reading on Hebrew and Arabic systems.

Resultcode meaning:
(reflects button choice made)
(from visual basic 6.0 doc)

1	OK
2	Cancel
3	Abort
4	Retry
5	Ignore
6	Yes
7	No

mul num1 num2 MUL num1*num2
Multiply two numbers.

not boo NOT boo
logical NOT operation

or boo boo OR boo
logical OR operation

packmem - PACKMEM -
Removes unreferenced source file subsections and updates pointers. Used to recover memory.

plotaxis xstart xend xunit$ ystart yend yunit$ color allowrescale
PLOTAXIS -
Plot x/y axis at left lower edge of graphics screen, Displays units in lower left corner, placing appropriately stepped marks and values along axis. If first char of 'unit' is '#' then strip first char and plot that axis as integer only. Set allowrescale=true to adjust x-axis up/down time units scale (hour/Min./Sec.) as appropriate.

plotcurve handle color spotflag penwidth PLOTCURVE -
Plot dataset using current window scaling.

plotline startx starty endx endy color linemode PLOTLINE -
Plots a simple line segment using current scalewindow settings.
linemode=0 for a simple line, 1 for empty box, 2 for filled.
Set linemode=1 for an open box.
Set linemode=2 for a filled box.

pop any POP -
Discards top entry from stack.

popdict - POPDICT -
Remove most recent entries from dictionary, back to and including most recent 'Mark', placed on dictionary stack by most recent 'pushdict' command.
Use with pushdict to create and discard local proc vars

popproc num POPPROC -
Multi-pop on execution stack
0 is NOP
1 is equivalent to 'exit', no code afterwards in current block is executed.
2 pops up one tier further
3 etc…

pushdict - PUSHDICT -
Pushes mark onto dictionary to protect extant definitions from replacement by new ones of same name.
Use with popdict to create local variables and procs.

quadfitone startdex enddex handle QUADFITONE [coeffx2 coeffx const] boo
Returns FALSE and no coefficients on failure.
On success returns quadratic regression fit coefficients and TRUE. Note that handle must point to the single dimensional data array to be fit. If a summary table already exists for such an array, use quadfittbl as it runs faster.

quadfittbl startdex enddex handle QUADFITTBL
[coeffx2 coeffx const] boo
Returns FALSE and no coefficients on failure.
On success returns quadratic regression fit coefficients and TRUE. Note that handle must include a full stats summary set. If such a table does not exist, use quadfitone or create the table with gensums.

readmxgfile mxgname mxgpath handle READMXGFILE [newhandle] boo
Loads a Mixograph data file (.MXG).
If handle is zero, return newhandle as new array.
If handle is nonzero assume valid destination array is
provided and don't provide new handle, just return boo.
During multiple data file loads (for comparative analyses),
The user must manage the shared defaults variables data area
Accessed via the 'MXG.' vars.
Returns boo=FALSE and no handle load failure.

readvar str READVAR any
Retrieves contents of defaults var (including MXG. Vars)
Identified by 'str' specified name.

Repeat num {proc} REPEAT -
Execute proc num times.

reportmxg - REPORTMXG boo
Generate full MixSmart reports (checking printer) on
loaded data set.
Returns true on success, false on error.

restorevars - RESTOREVARS –
copy accessible defaults vars and mxgvars back from local
store. Use with savevars. Operation cannot be nested.

rgb red green blue RGB rgbval
Converts ordered triple (0-255 each)
to composite color value.

roll depth travel ROLL (rearranged stack)
Reaches down depth entries into stack
and rotates up (+travel) or down (-travel) units

rootsumsquare
Ahandle Bhandle ROOTSUMSQUARE MAGhandle
Generates new table as pythagorian magnitude of two tables.

rptread row col section RPTREAD num
Reads a data cell from the current text report output
data array. This function returns only a numeric
interpretation of the output table. It is possible to write
text strings to the output array, but this function will
only return a numeric equivalent to the string (typically
zero).

rptwrite any row column section RPTWRITE
Sends a number or string to pending MixSmart report table.
Row and col refer to sections of a report sub-block.
Zone selects which sub block to alter
(1=envelope, 2=midline, 3=user).

rptwritecolfmt
name units fmt column section RPTWRITECOLFMT -
Sets up a section's report column heading and units.

rptwritedesc
description section RPTWRITEDESC -
Sets up a section description.
If set to "" then disable all report text for this section.
Note: the description field starts out as "", but it must be
actively set to "" in order to suppress output.
This function can also re-enable output for
report blocks shut off by 'enable' options in the
user preferences, but does not actually reactivate
such analyses.

rptwriterowname
name row section RPTWRITEROWNAME -
Sets up a report row name.

rtrim srcstr strlist RTRIM substr
Removes substring from right side of main string and return
result.

savevars - SAVEVARS -
copy accessible defaults vars and mxgvars to local store for
preservation. Use with restorevars. Operation cannot be
nested.

scalewindow
winstartdex winymin winenddex winymax SCALEWINDOW -
Sets current graphics screen scaling for subsequent plots by
plotcurve or plotline. Winstartdex and winymin fit the
lower left corner of the screen while the other two values
mark the upper right corner.

screenwrite
any x y color SCREENWRITE -
Write any to pgmplotbox starting at scaled x,y location.
Use for on-screen reports, warnings, and summaries.
'any' can be anytype.
String origin point is upper left corner of string.

setfont fontsize fontname SETFONT -
Set font size (in points) and font name (as string)
to be used by 'screenwrite' commands
fontname must be the exact Windows name of the font
pass this argument as "" to leave current font unchanged

setlinewidth
num SETLINEWIDTH -
Sets width in pixels of line for 'plotline' commands.
Default is one, requires active 'pgmplotbox'.
This value is overwritten by 'plotcurve'
and it is reset to '1' in PlotAxis.

sin num SIN sin(num)
Returns sine of degree argument.

sqr num SQR num^.5
Returns square root of argument.

stksize - STKSIZE stksize
Pushes current data stack size onto data stack

sub num1 num2 SUB num1-num2
Subtracts two numbers, placing the difference on the stack.

textsize any TEXTSIZE width height
Finds width and height (in current screen scale) of argument for current font size and typeface.

time - TIME str
Pushes current system time onto stack as string.

timer - TIMER num
Pushes No. seconds elapsed since midnight onto stack.

true - TRUE boo
Pushes boolean constant, TRUE, onto stack.

type any TYPE str
Pops top element off stack and push its type as a string.

ucase str UCASE ucase(str)
Converts string to upper case.

undef key UNDEF -
Removes key and its definition from dictionary.

writemxgfile
name path extension handle WRITEMXGFILE -
Creates an MXG data file.
Exports main data from an array.
Clips oversized TO +/- 32767.
If name, path, or extension are blank will use from MXG.???
Vars. At save, data contents of handle replaces mxgvar.Chan(1).Data(), channel count is set to 1, and numpoints are updated.
These changes are reflected in mxg. vars until another .mxg file is loaded.

writevar any namestr WRITEVAR -
Writes 'any' to 'defaults var' or 'mxg.' var of specified name.

writevarfmt descstr fmtstr namestr WRITEVARFMT -
If fmtstr has "|", assume concatenated list.
Main part of fmtstr is 'str', 'boo' or '##...".
If Main part is "" then do not alter format value,
But still update description.
This also sets a var's type for subsequent read/write.
If descstr = "" then disable this var.
Normally used to alter the format of uservars only.

xor boo boo XOR boo
Logical exclusive-OR operation

zeroallhandlevars
- ZEROALLHANDLEVARS -
Erases all defined raw data tables and their pointers.

Chapter 18

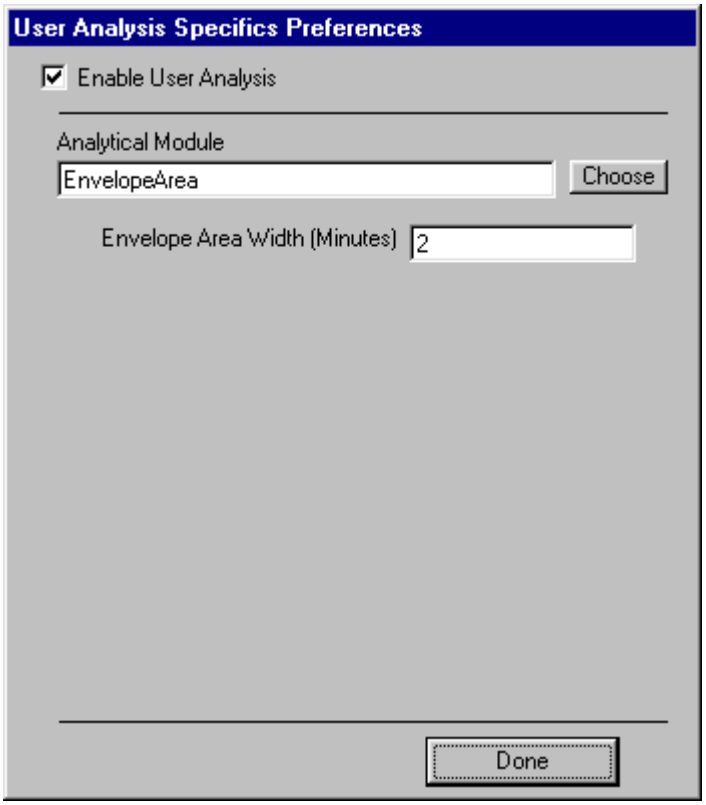
Example User .PGM Modules

18.1 Envelope Area Analysis (EnvelopeArea.PGM)

The following file listing is typical of a user's program module serving a specialized purpose in the MixSmart system. This example replaces the 'Envelope Area' analytical option which was built into earlier versions but has been removed as of (DOS) MixSmart v4.00.

This example contains the two most common (and often required) subsections in a PGM file. The first section begins with the line '[PRELOAD]', which follows the authorship/purpose comment block. This section is processed right after the defaults variables profile is selected and loaded, but before the main menu is displayed. It is most commonly used to alter the defaults variables presented on the User's analysis menu. This allows tailoring the MixSmart menus to match the requirements of the special user's function just loaded. Beginning in MixSmart For Windows, procedure and variables definitions persist during an entire MixSmart session. They can still be replaced by a new definition of the same name or deleted from within a .PGM module, of course. Also new to the Windows version are several resource management utilities like 'cleardict' which erases the entire dictionary.

The [PRELOAD] section commonly begins with an 'INCLUDE' directive. In the following example, the [PRELOAD] section of the 'STDINCL.PGM' file is loaded and invoked as a precursor to the other work here. This library file, included with MixSmart, contains common procedure definitions for manipulating the defaults variables and menus. In this example, a single user defined defaults variable 'Envelope Area Width (Minutes)' is configured in the defaults variables section of the 'User's Analysis Control Menu'. These manipulations produce the following User Analysis Control menu:



The other section in the example file, [USER], is invoked at the end of each data (.MXG) file analysis. This procedural block is used to alter the created report including rewording, removal, or adding sections to the text report. This section can is also be used to add text and special analytical lines to the screen plot. Like the [PRELOAD] section, a standard library is usually invoked as the first line of this module. The library specified here (the [USER] section of the STDINCL.PGM file) contains many constants definitions and standard procedures which have proven useful in this and other PGM modules. The STDINCL.PGM file is included for reference in Chapter 19.

The following sample report includes the User analysis generated by EnvelopeArea.PGM:

```
                        SPEC. SHEET SAMPLE RUN
-------------------------------------------------------------------------
SAMPLE.MXG                                  Created: 05-23-1990 08:13:28
            Profile: ENVELOPEAREA.INI    Analyzed: 12-15-2003 11:46:22

VARIABLE DESCRIPTION       VALUE   | VARIABLE DESCRIPTION       VALUE
------------------------- ------- | ------------------------- -------
Total Run Time (Min.)        10.00 | Frequency (Samples/Sec)     10.000
Pre-Analysis Filter           1.010 | Pre-Analysis No. Stages          0
Mid Curve Filter             80.000 | Mid Curve No. Stages             2
Delta Left of Peak (Min.)     1.00 | Delta Right of Peak           1.00
TORQUE Min. Std. Reading      2096 | TORQUE Max. Std. Reading      2699
Analysis Start Time (Min.)    0.00 | Delta End Time                0.00
Top Finder Window (Sec.)      0.70 | Bottom Finder Window (Sec.    0.70
Top Curve Filter             80.000 | Top Curve No. Stages             2
Bottom Curve Filter          80.000 | Bottom Curve No. Stages          2
Arbitrary Time 'X' (Min.)     mp*2 | Envelope Slope Scanning Wi    5.00
Use Manual First Mid Peak       No | Mid Peak Fit Window (%)       5.00
Use Manual First Top Peak       No | Top Peak Fit Window (%)       5.00
Moisture (%)                 14.00 | Mixer Type                 10g Fix
Protein (%)                  13.00 | Data Sampling Method         Sync.
Ash (%)                       0.90 | Main Shaft RPM               88.01
Absorption (%)               63.00 | Sample Type                    HRW
Operator Name              ALAN WA | Sample Alternate/Customer
-------------------------------------------------------------------------


                          Time     Value     Slope     Width    Integral
ENVELOPE ANALYSIS:      (Min.)     (%)     (%/Min.)    (%)    (%Tq*Min)
---------------------- --------- --------- --------- --------- ---------
LEFT_OF_PEAK               2.39    75.020    19.099    42.034    74.031
PEAK                       3.40    85.310     0.000    40.660   117.699
RIGHT_OF_PEAK              5.87    60.397   -15.793    15.857   182.185
CURVE_TAIL                10.00    46.782    -1.642    11.553   236.080
TIME_'X'                   7.34    53.230    -2.348    13.858   202.960


                          Time     Value     Slope     Width    Integral
MID LINE ANALYSIS:      (Min.)     (%)     (%/Min.)    (%)    (%Tq*Min)
---------------------- --------- --------- --------- --------- ---------
LEFT_OF_PEAK               2.67    56.794    14.283    43.647   105.496
PEAK                       3.67    65.107     0.000    37.449   167.601
RIGHT_OF_PEAK              4.67    59.855    -7.454    24.693   230.729
CURVE_TAIL                10.00    41.117    -0.972    11.553   485.293
TIME_'X'                   7.34    46.332    -2.369    13.858   369.801


ENVELOPE AREA              Time     Value     Slope     Width    Integral
USER ANALYSIS:           (Min.)     (%)     (%/Min.)    (%)    (%Tq*Min)
---------------------- --------- --------- --------- --------- ---------
TIME_RANGE    3.67 To      5.67
MID_LINE_SLOPE                                -6.385
ENVELOPE_AREA                                                      50.952
```

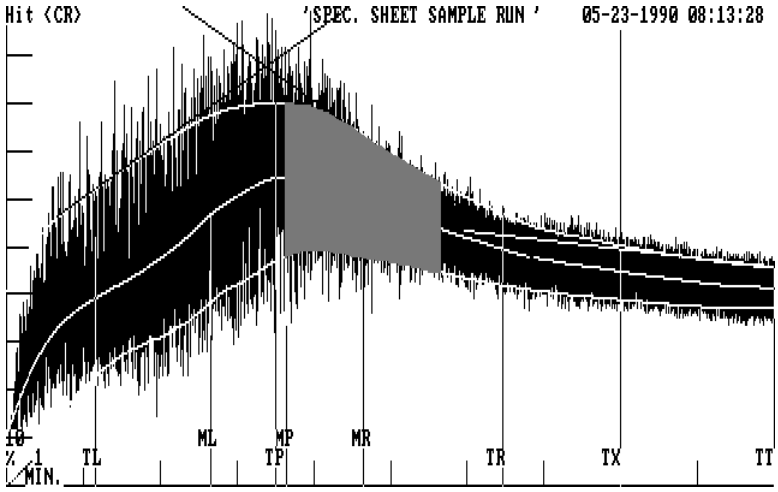
This report provides two new pieces of information about a small region to the right of the mid line peak. These new results along with the .PGM-defined are described here.

Envelope Area Width (Minutes), accessed internally as uservar0, this menu entry specifies the time region, relative to the mid line peak, over which to perform an area calculation. The exact boundaries of this area are as follows:

Left: mid line peak time
Right: mid line peak time + Envelope Area Width
Top: envelope top curve
Bottom: envelope bottom curve

This roughly trapezoidal region, when used with the relatively standard 2.00-minute value for the user variable, provides a number proportional to the average width of the envelope in the zone immediately after mid line peak. This value, while good for comparing to others of its kind, should not be mistaken for the true work integrals provided in the mid line analysis. An actual force over time (work) integral is not strictly applicable to curves bounded by the envelope.

As an aid to explanation, the following picture of the example's graphical output has been shaded to show the Envelope Area Analysis region. The EnvelopeArea.PGM module does not put any marks on the graph.

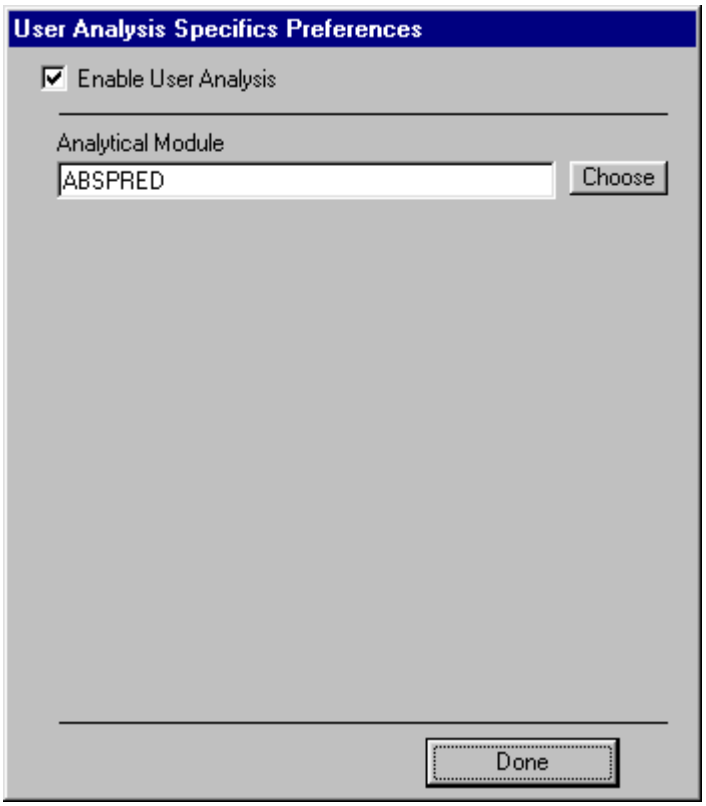


The other new piece of information in this report block is also based on the user variable. Called the mid line slope, it is calculated by performing a linear regression on the filtered mid line over the time region just described. This value can be expected to be similar to the mid line right of peak slope value, but not identical.

Finally, the remainder of this section is the full listing of the source file. Excepting those functions defined in the STDINCL.PGM library (see chapter 19), all of the operations necessary to generate this emulation of the old hard-coded Envelope Area Report are in this file.

```
; ************************  ENVELOPEAREA.PGM  ****************************
; ***********************************************************************
; ENVELOPE AREA ANALYTICAL ADD-IN MODULE FOR MIXSMART
; WRITTEN BY Alan E. Walker AEW Consulting
; * 02 March   2003   formally conversted to MixSmart Windows
; LAST MODIFIED
; 03/02/2003
; 07/26/2003 shifted uservar indexes from 1--10 to 0--9

; ***********************************************************************

[PRELOAD]
; PRE-ANALYSIS MODULE FOR SETTING UP CUSTOM MENUS AND VARIABLES

"PRELOAD" "STDINCL" INCLUDE
     HIDEALLUSERVAR
     "Envelope Area Width (Minutes)" "###.###" "uservar0" writevarfmt

; ***********************************************************************

[USER]

    clearstack

    "user" "STDINCL" INCLUDE  ; INITIALIZATION FILE FOR STANDARD LIBRARY

    /STARTTIME 2 1 2 RPTREAD DEF
    /ENDTIME starttime "uservar0" readvar ADD DEF
    /RAWSTARTTIME STARTTIME MINUTESTOINDEX DEF
    /RAWENDTIME ENDTIME MINUTESTOINDEX DEF

    "ENVELOPE AREA"    3 rptwritedesc
    "TIME_RANGE  " STARTTIME "###.##" FORMAT ADDSTR " To " ADDSTR
                    1 3 rptwriterowname
    "MID_LINE_SLOPE" 2 3 rptwriterowname
    "ENVELOPE_AREA"  3 3 rptwriterowname
    ""               4 3 rptwriterowname
    ""               5 3 rptwriterowname

    ENDTIME          1 1 3 rptwrite

    RAWSTARTTIME RAWENDTIME MIDHANDLE LINFITtbl
    {POP PERIOD DIV 60 MUL 2 3 3 RPTWRITE}
    {"UNABLE TO SOLVE ENVELOPE AREA SLOPE LINE FIT" ERRLOGWRITE}
    IFELSE

    RAWENDTIME TOPAREAHANDLE ARRAYREAD
    RAWSTARTTIME TOPAREAHANDLE ARRAYREAD
    SUB
    RAWENDTIME BOTAREAHANDLE ARRAYREAD
    RAWSTARTTIME BOTAREAHANDLE ARRAYREAD
    SUB
    SUB
    PERIOD MUL 60 DIV
    3 5 3 RPTWRITE

; ***********************************************************************
; ************************  EnvelopArea.PGM ENDS ************************
```

18.2 Mixograph Absorption Predictor (ABSPRED.PGM)



As currently implemented, this module requires no user input. Employing equations developed at Kansas State and making the assumption that a comparable Mixograph and flour type is being used, this add-in estimates the correct Mixograph absorption based on the absorption used in making this data collection and other attributes like the protein content of the flour. The actual recommended value for this run (70.79%, up from the actual absorption used of 63.00%) is probably nonsensical due to the arbitrary numbers keyed for the moisture and protein values in this example. However, with proper care, this prediction method can be a useful tool. For an in-depth discussion of the research which lead to the equations in this module see Chapter 21 in this document and also reference #7 in the Bibliography section (Chapter 20).

Users who wish to customize this module to more closely match their wheat varieties and production needs are encouraged to contact the authors of the original paper or National Mfg. for assistance.

SPEC. SHEET SAMPLE RUN

SAMPLE.MXG Created: 05-23-1990 08:13:28
Profile: ABSPRED.INI Analyzed: 12-15-2003 11:51:28

VARIABLE DESCRIPTION	VALUE	VARIABLE DESCRIPTION	VALUE
Total Run Time (Min.)	10.00	Frequency (Samples/Sec)	10.000
Pre-Analysis Filter	1.100	Pre-Analysis No. Stages	0
Mid Curve Filter	80.000	Mid Curve No. Stages	2
Delta Left of Peak (Min.)	1.00	Delta Right of Peak	2.00
TORQUE Min. Std. Reading	2096	TORQUE Max. Std. Reading	2699
Analysis Start Time (Min.)	0.00	Delta End Time	0.00
Top Finder Window (Sec.)	0.70	Bottom Finder Window (Sec.	0.70
Top Curve Filter	80.000	Top Curve No. Stages	2
Bottom Curve Filter	80.000	Bottom Curve No. Stages	2
Arbitrary Time 'X' (Min.)	8	Envelope Slope Scanning Wi	7.50
Use Manual First Mid Peak	No	Mid Peak Fit Window (%)	5.00
Use Manual First Top Peak	No	Top Peak Fit Window (%)	5.00
Moisture (%)	14.00	Mixer Type	10g Fix
Protein (%)	13.00	Data Sampling Method	Sync.
Ash (%)	0.90	Main Shaft RPM	88.01
Absorption (%)	63.00	Sample Type	HRW
Operator Name	ALAN WA	Sample Alternate/Customer	

ENVELOPE ANALYSIS:	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min)
LEFT_OF_PEAK	2.39	74.929	19.101	41.991	73.821
PEAK	3.40	85.310	0.000	40.660	117.699
RIGHT_OF_PEAK	5.87	60.384	-15.780	15.854	182.211
CURVE_TAIL	10.00	46.782	-1.642	11.553	236.080
TIME_'X'	8.00	51.088	-3.087	12.824	211.821

MID LINE ANALYSIS:	Time (Min.)	Value (%)	Slope (%/Min.)	Width (%)	Integral (%Tq*Min)
LEFT_OF_PEAK	2.67	56.794	14.283	43.647	105.496
PEAK	3.67	65.107	0.000	37.449	167.601
RIGHT_OF_PEAK	5.67	53.505	-6.079	16.297	287.298
CURVE_TAIL	10.00	41.117	-0.972	11.553	485.293
TIME_'X'	8.00	44.796	-2.528	12.824	399.911

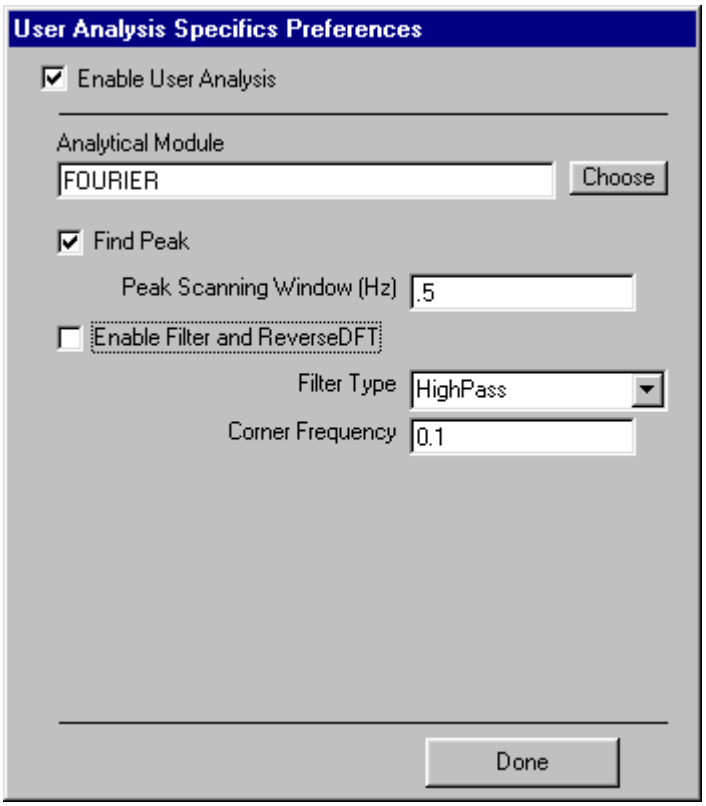
USER ANALYSIS:	Finney's Rule	Actual Used	Calc'd Adjust.	Calc'd New Value
Absorption (%)	63.100	63.000	7.792	70.792

```
; ******************************** ABSPRED.PGM ********************************
; ****************************************************************************
; * C.E. Walker / J. Hazelton Mixograph Absorption Estimator
; * SPECIAL EQUATIONS REPORT ADD-IN MODULE WRITTEN FOR MIXSMART
; * WRITTEN BY Alan E. Walker / AEW Consulting
; * File Created 11-19-2000     14:31:01
; * MODIFIED:
; * 11/27/2000
; * 08/05/2001 REMOVED COEFFICIENTS FROM DEFVARS AND MOVED INTO HARDCODE
; * 09/30/2002 ADDED CLIPPING TO 'LINFITHEIGHT' SO IT CAN'T OVERRUN
; *            DATA INDEX RANGE (I.E.  1--NUMPOINTS).
; *            ADDED SAME CLIPPING TO ALL INDEX ADJUSTMENTS, INCLUDING
; *            '@10 MINUTES' READINGS WHICH PREVIOUSLY ERRORED OUT
; *            THE PGM PROCESSOR ON SHORTER THAN 10 MINUTE RUNS.
; *            NOTE THAT A RUN LESS THAN 10 MINUTES VIOLATES THE EXPERIMENTAL
; *            MODEL ON WHICH THIS MODULE IS BASED, BUT NOW USERS WILL STILL
; *            BE ABLE TO GET RESULTS.
; * 04/07/2003 converted to MixSmart for Windows v1.0
; ****************************************************************************

[PRELOAD]
; PRE-ANALYSIS MODULE FOR SETTING UP CUSTOM MENUS AND VARIABLES

"PRELOAD" "STDINCL" INCLUDE

     HIDEALLUSERVAR

; ============================================================================

[USER]
clearstack
cleardict
packmem

"USER" "STDINCL" INCLUDE  ; INITIALIZATION FILE FOR STANDARD LIBRARY

; NOTE: THESE CONSTANTS WERE DEVELOPED FOR 10G (& 35G?) ONLY
;       EVENTUALLY SETS FOR THE 2G AND OTHERS WILL BE CREATED
;       AND A USER'S SELECTION VARIABLE WILL BE PRESENTED OR THE MIXER TYPE
;       WILL BE DRAWN FROM DEFAULTS VARIABLES

     /CONST    28.611   DEF ; Constant
     /CWR      59.794   DEF ; Coeff. Width_Ratio
     /CWR2     12.177   DEF ; Coeff. Width_Ratio^2
     /CLPH2     0.008   DEF ; Coeff. Left_of_Peak_Height^2
     /CRPI2     0.00006 DEF ; Coeff. Right_of_Peak_Integral^2
     /CWRH55    0.843   DEF ; Coeff. Width_Ratio*Height@55
     /CH55TH10  0.004   DEF ; Coeff. Height@55*Tail_Height@10

;       LINEAR REGRESSION FIT AT +/- 2.5% OF RUNTIME TO GET TRUE 'HEIGHT'
;       THIS PROCEDURE ADDED SO THAT EXTRACTED LEFT-OF-PEAK AND RIGHT-OF-PEAK
;       HEIGHT VALUES WILL MATCH STANDARD MIDLINE ANALYSIS WHICH USES LINEAR
;       CURVE FIT
/LINFITHEIGHT {
        ; TimeIndex Handle LINFITVAL BestValue@Index
        ; FIT STRAIGHT LINE FOR LEFT OF PEAK SLOPE AND VALUE
        PUSHDICT
        /HANDLE EXCH DEF
        /TIMEINDEX EXCH DEF
        /DELTA .025 NUMPOINTS MUL DEF  ; I.E. +- 2.5% FIT WINDOW
```

```
        TimeIndex DELTA SUB LIMITTIMEINDEX
        TimeIndex DELTA ADD LIMITTIMEINDEX
        Handle LINFITONE POP
        /Const   EXCH DEF
        /CoeffX  EXCH DEF
        CoeffX TimeIndex MUL Const ADD ; GET ESTIMATED VALUE FROM LINEAR FIT
        POPDICT
        } DEF

/LIMITTIMEINDEX {  ;HELPER FUNCTION FOR 'LINFITHEIGHT'
        DUP 1 LT {POP 1} IF
        DUP NUMPOINTS GT {POP NUMPOINTS} IF
        }DEF
; ============================================================================

        PUSHDICT

        "Absorption (%)" 1 3 rptwriterowname
        "" 2 3 rptwriterowname
        "" 3 3 rptwriterowname
        "" 4 3 rptwriterowname
        "" 5 3 rptwriterowname

        "Finney's" "Rule"      "#####.###" 1 3 rptwritecolfmt
        "Actual"   "Used"      "#####.###" 2 3 rptwritecolfmt
        "Calc'd"   "Adjust."   "#####.###" 3 3 rptwritecolfmt
        "Calc'd"   "New Value" "#####.###" 4 3 rptwritecolfmt
        ""         ""          ""          5 3 rptwritecolfmt

        /MIDPEAKTIME 2 1 2 RPTREAD DEF
        /RAWMIDPEAKTIME MIDPEAKTIME MINUTESTOINDEX DEF

        ; FINNEY PREDICTED ABSORPTION
        "mxg.protein" readvar 1.5 MUL 43.6 ADD
        1 1 3 RPTWRITE

        ; ACTUAL ABSORPTION
        "mxg.absorption" readvar
        1 2 3 RPTWRITE

        ; TERMS FROM PUBLISHED PAPER FOR 10G/35G MIXOGRAPH:
        /A
          2 4 2 rptread
          RAWMIDPEAKTIME .55 MUL DUP
          TOPHANDLE ARRAYREAD
          EXCH BOTHANDLE ARRAYREAD
          SUB
          DIV
        DEF

        /B
          RAWMIDPEAKTIME 1.00 MINUTESTOINDEX SUB LIMITTIMEINDEX
          MIDHANDLE LINFITHEIGHT
        DEF

        /C
          RAWMIDPEAKTIME 2.00 MINUTESTOINDEX ADD LIMITTIMEINDEX
          MIDAREAHANDLE ARRAYREAD INDEXTOMINUTES
        DEF
```

```
        /D
          RAWMIDPEAKTIME .55 MUL MIDHANDLE ARRAYREAD
        DEF

        /E
          10 MINUTESTOINDEX LIMITTIMEINDEX
          MIDHANDLE ARRAYREAD
        DEF

        ; REGRESSION PREDICTED ABSORPTION
        CONST
        CWR       A MUL        SUB
        CWR2      A MUL A MUL  ADD
        CLPH2     B MUL B MUL  SUB
        CRPI2     C MUL C MUL  ADD
        CWRH55    A MUL D MUL  ADD
        CH55TH10  D MUL E MUL  ADD
        DUP ; NEED A COPY FOR SUGGESTED ABSORPTION VALUE
        1 3 3 RPTWRITE

        "mxg.absorption" readvar ADD
        1 4 3 RPTWRITE

;        CLEARSTK "E" E D C B A "A" PSTK; FOR HAND CALCULATION TO TEST MATH

        POPDICT

; ***************************************************************************
; ***************************** ABSPRED.PGM ENDS ****************************
```

18.3 Fourier Transform Demo



The User analysis menu above and the graphics on pages 13 through 17 were generated using the Fourier.PGM module which is included in the set of supplemental programs and listed at the end of this discussion. These examples demonstrate the Discrete Fourier Transform (DFT) and its reverse (ReverseDFT)-- functions which have been added to the MixSmart .PGM language. Frequency domain analysis is a very useful tool in communications and image processing and we always felt it could tell us something about the Mixograph curve. Unfortunately, most of the literature on the technique is either very theoretical and difficult to translate into a practical analysis or is a canned routine with too-little information to validate it for our purposes. Eventually, enough sources were distilled to eliminate the surprising amount of simply wrong information and produce what is demonstrated here.

This module runs as a standard add-in and can be applied to any .MXG data set. It does not put any useful data on the report form and erases any standard graphical analyses before beginning its own work. For this reason we Suggest leaving 'Enable Envelope Analysis' and Enable Mid Line Analyse' both disabled.

In all of the following plots, the trace along the baseline is the DFT of the main Mixograph plot (the midline through its center is plotted for reference only).

The vertical scale is in percent of the full screen size required to display the entire vertical expanse of the DFT. We found that only the bottom 5% was particularly interesting. The very large spikes about 0.0 Hz (i.e. the DC and near-DC components) overwhelm the image if it is scaled to show the full vertical range.

Note that DFT's produce real and imaginary components. Most graphs display the 'RootSumSquare' magnitude of these two parts. Internally, however, the MixSmart DFT and ReverseDFT functions produce and require both sets of data. In practice, the result of a ReverseDFT is usually assumed to be real only and the imaginary part is discarded.

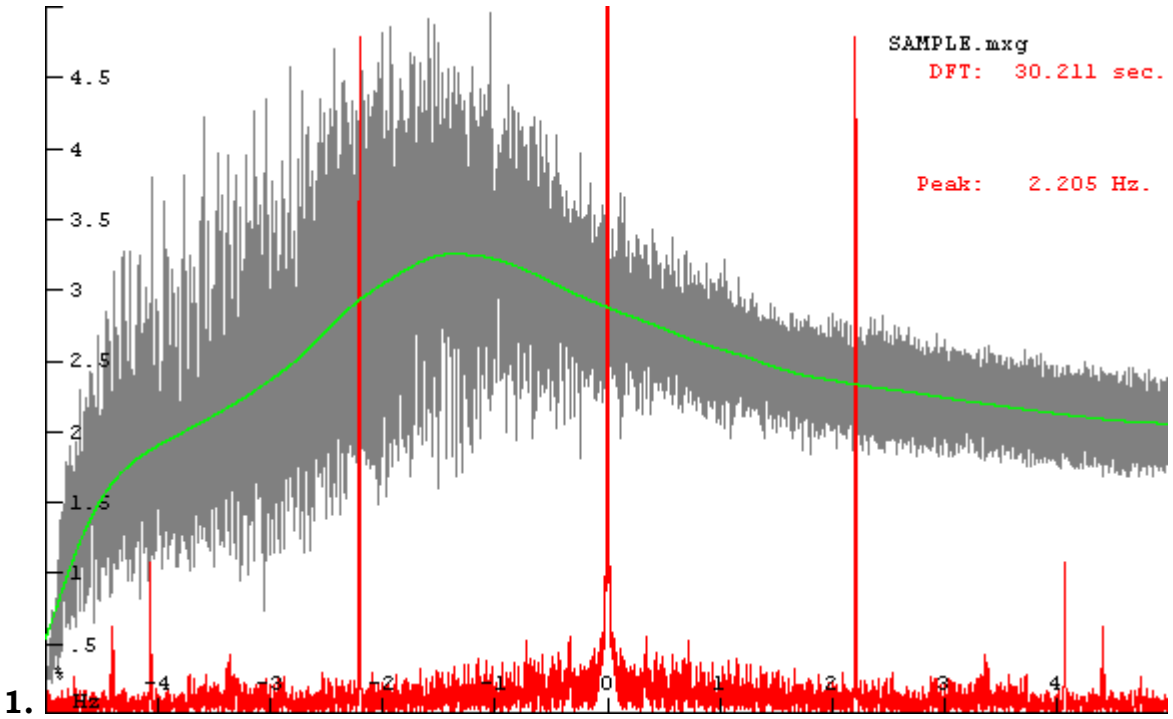
The horizontal scale spans +/– SamplingFrequency/2. While it appears that the data as graphed is symmetric about Frequency=0, remember that this is a magnitude plot. The separate components should not be symmetric. Graphing the separate parts of a DFT is not difficult, but not done here.

For the first curve only, the 'Find Peak' option is selected and the 'Enable Filter and Reverse DFT' option is not. This allows the user to graphically select a region of interest. The module then looks in the specified window about the chosen frequency for a local maximum amplitude. This location, adjusted for the horizontal units, is the 'Peak:' value printed on image 1.

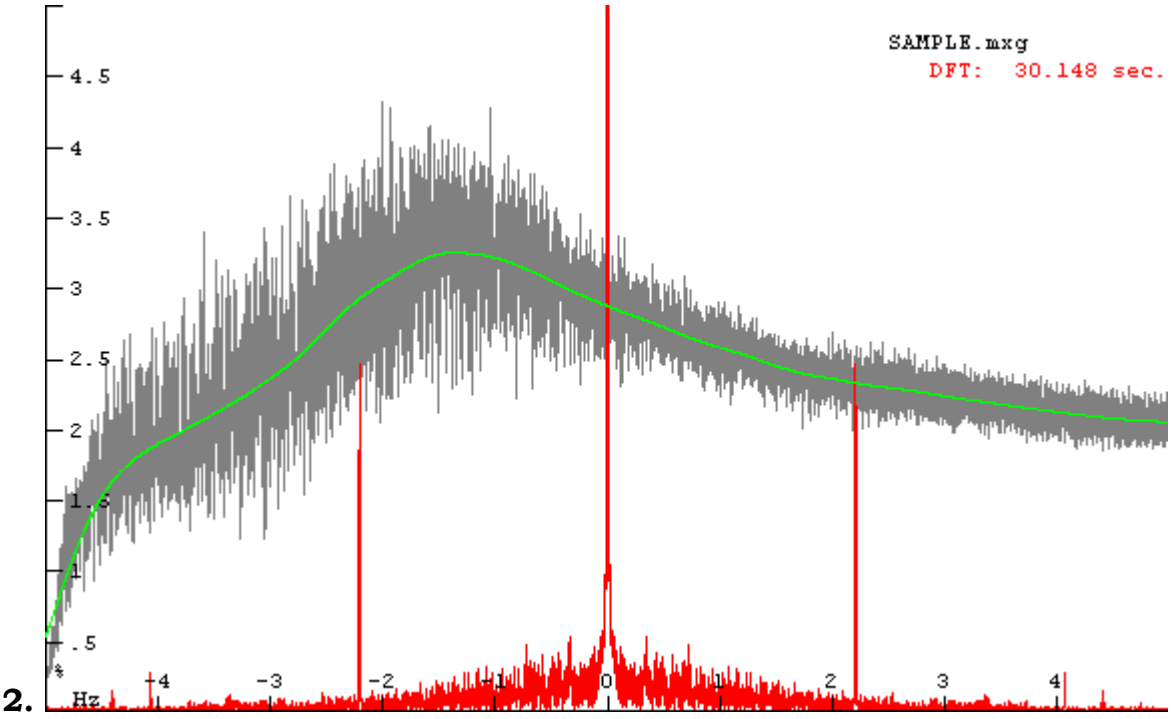
The peak of interest, 2.2 Hz (-2.2 Hz could just as well have been sought), indicates that the fundamental frequency of a Mixograph is once every 240 degrees of rotation (assuming a standard 88 rpm mixer). Note that this is independent of sampling frequency so long as it is well above twice the frequency of interest. All of these results were generated using the included 'Sample.MXG' data set which was recorded asynchronously at 10Hz (a very long time ago).

Since the established synchronous sampling mode is twice as frequent at once every 120 degrees, this is very curious and worthy of future investigation. As a check, the ADCComm system was also fed from a signal generator and run at various sampling rates to confirm the plotting scales and other calculations. However, being suspicious by nature of anything which is too precise, it would be very interesting to try these tests on variable speed mixers to confirm that the fundamental frequency (i.e. 2.2 Hz) is a linear function of rpm.

Some of the numbers on these graphs describe the time (in seconds) required to perform various stages in the analysis. This was merely for debugging, but shows that DFT's are very CPU intensive. An FFT (Fast Fourier Transform) would be immensely quicker, but requires that the original number of elements in the data set be an exact power of two (2048, 4096, 8192, etc.).



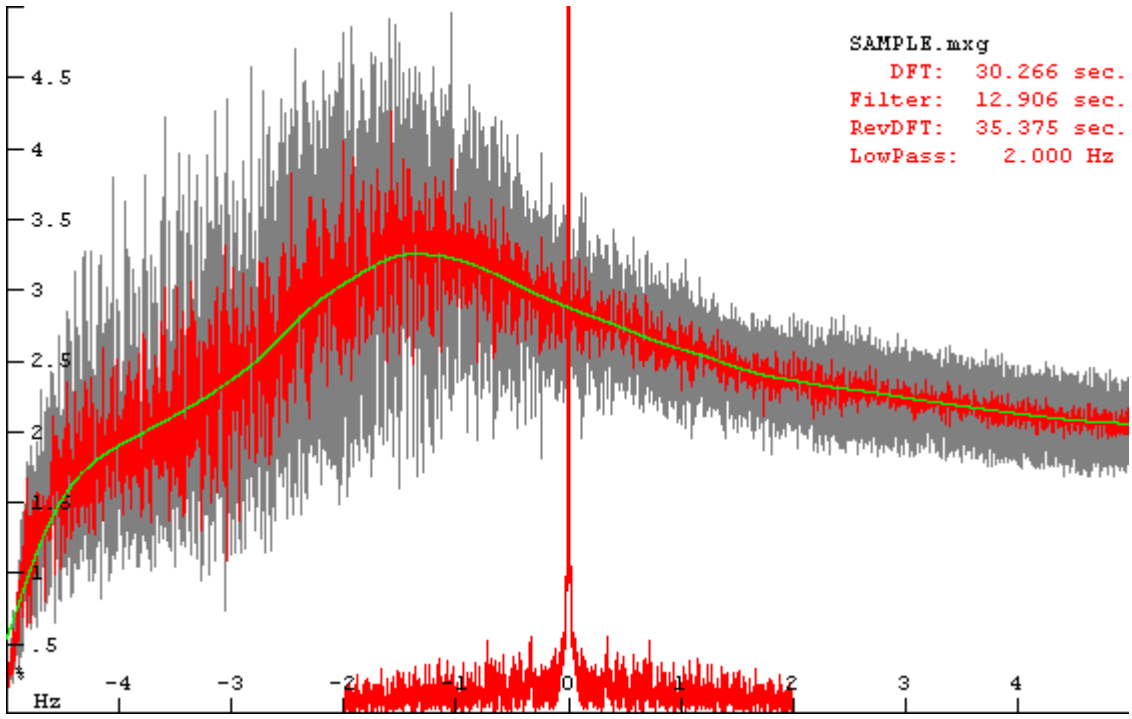
1.



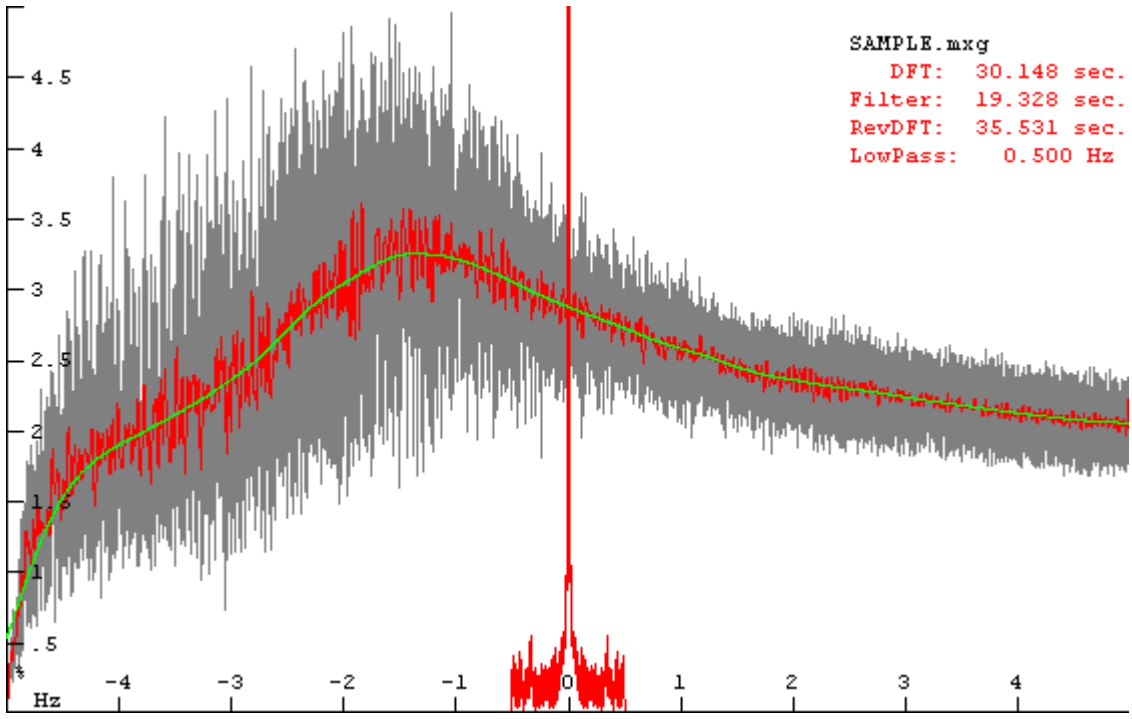
2.

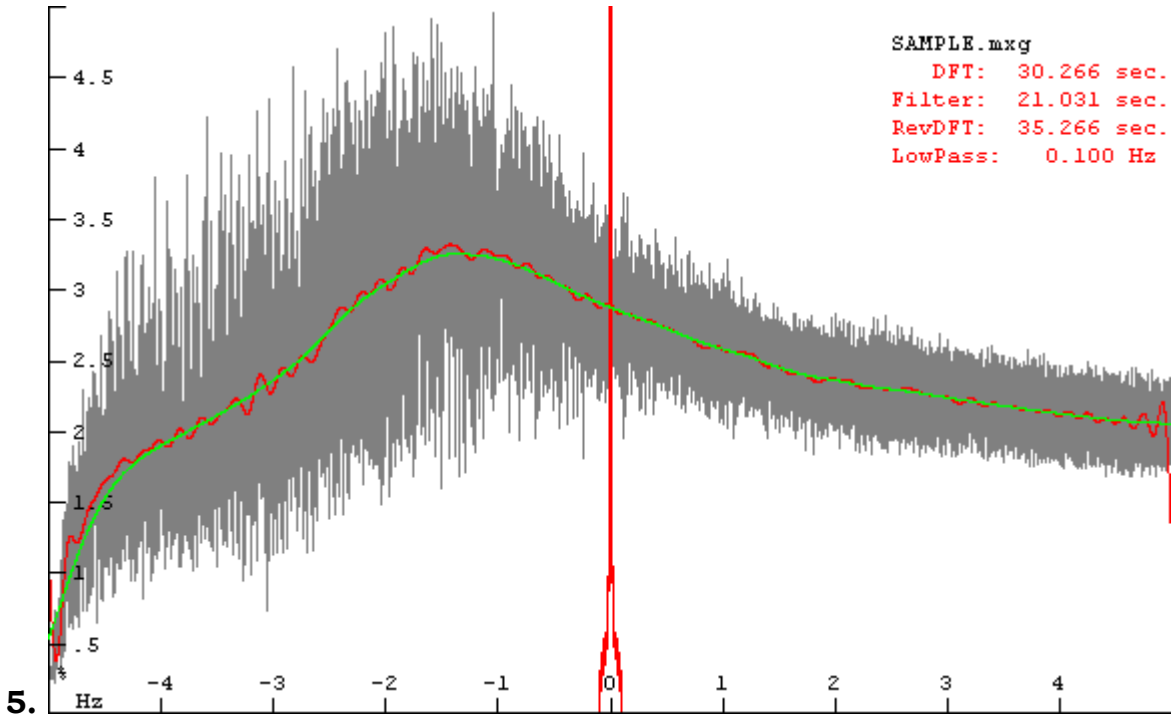
Figures 1 and 2. In the lower image, the raw data curve has been prefiltered (strength=1.1, stages=4) vs no prefiltering on the first curve and all subsequent ones. This acts as a lowpass filter which is confirmed by the rolloff of the higher frequency components in the DFT plot of figure 2.

3.


SAMPLE.mxg
DFT: 30.266 sec.
Filter: 12.906 sec.
RevDFT: 35.375 sec.
LowPass: 2.000 Hz
4.5
4
3.5
3
2.5
2
1.5
1
.5
-4
-3
-2
-1
0
1
2
3
4
Hz

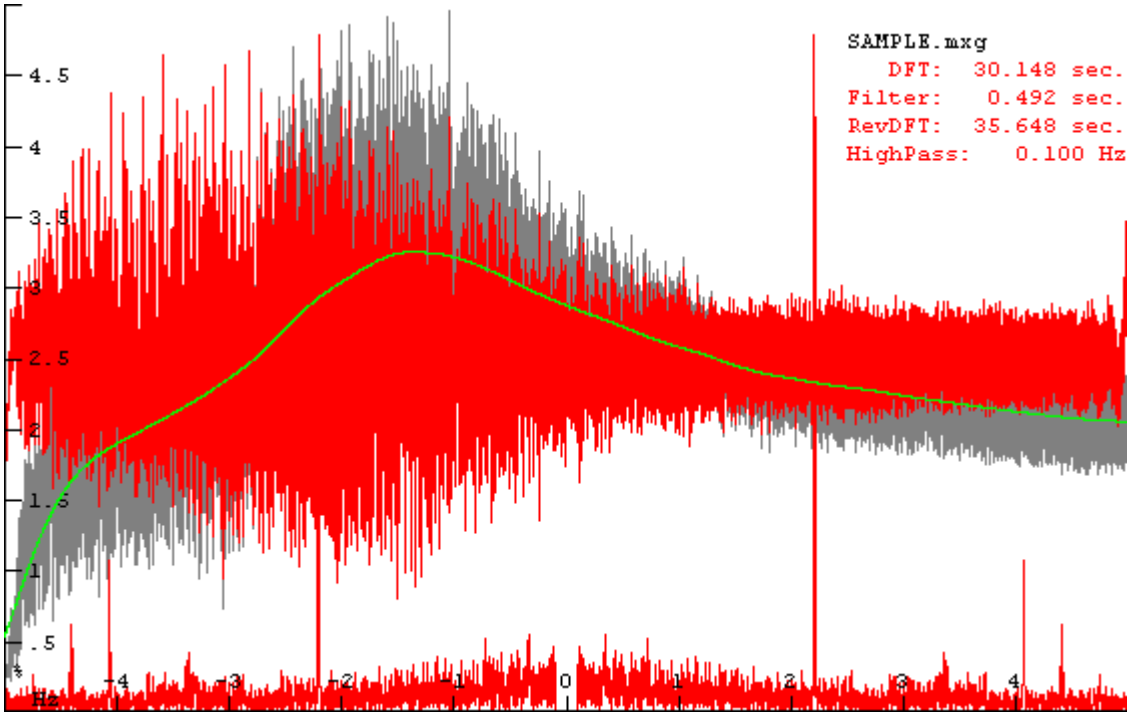
4.

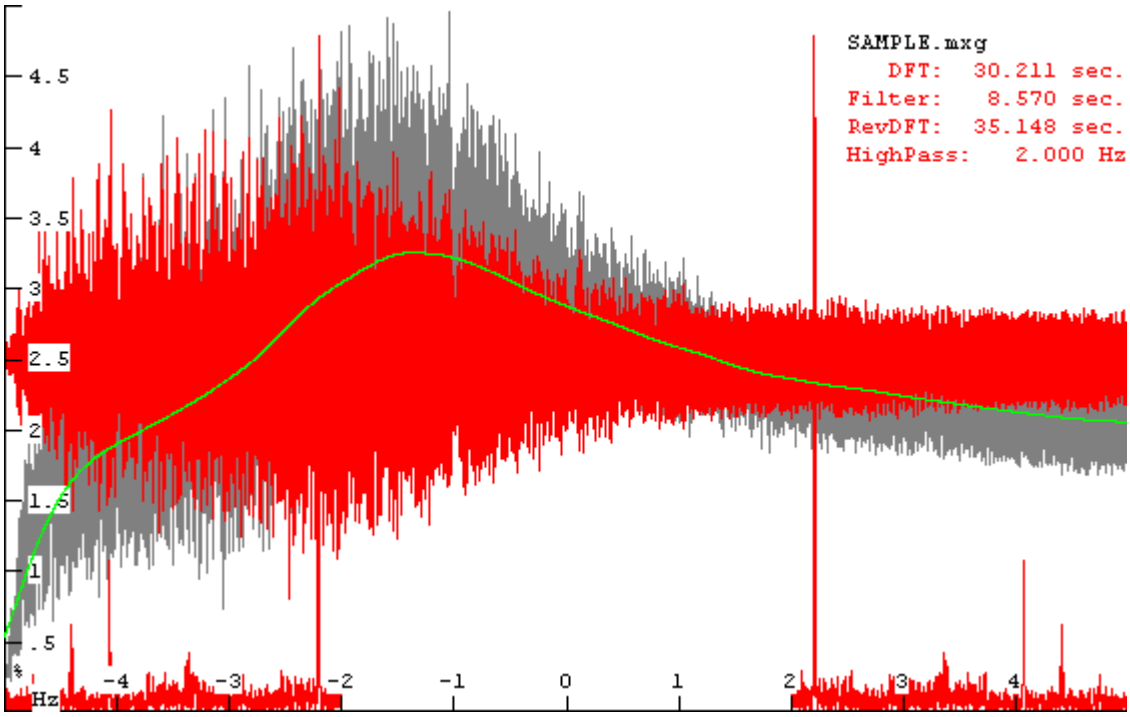

SAMPLE.mxg
DFT: 30.148 sec.
Filter: 19.328 sec.
RevDFT: 35.531 sec.
LowPass: 0.500 Hz
4.5
4
3.5
3
2.5
2
1.5
1
.5
-4
-3
-2
-1
0
1
2
3
4
Hz

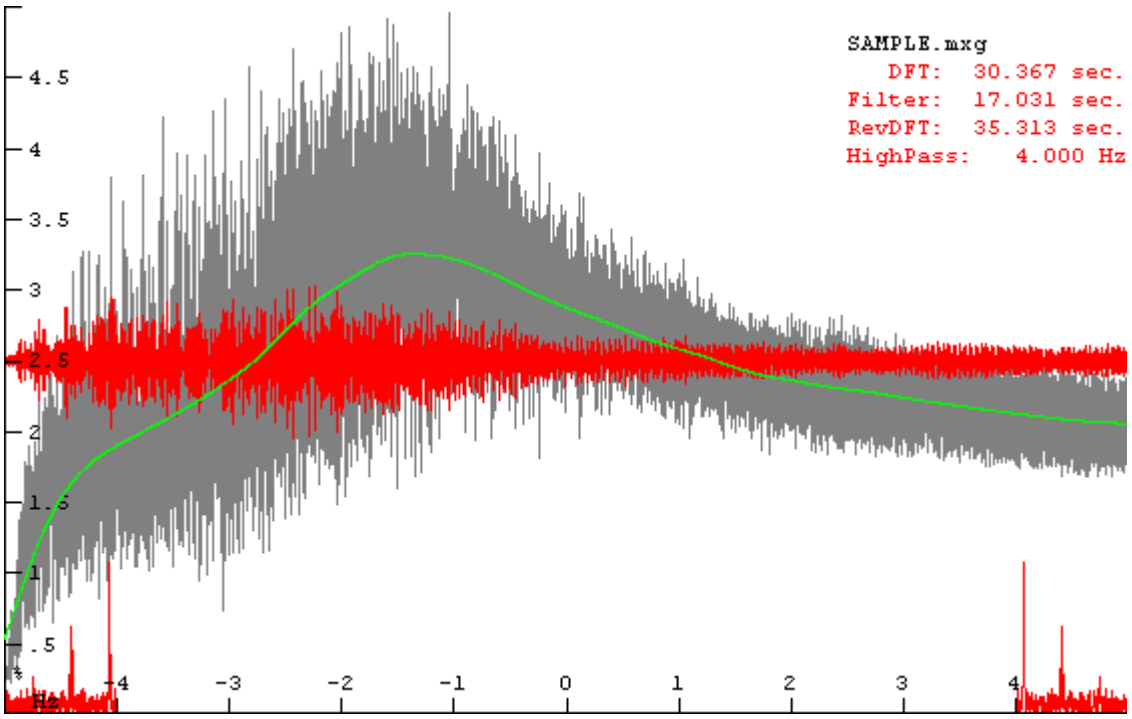


5.

Figures 3, 4, and 5. This sequence discards an increasing fraction of the higher frequency data. This is done by zeroing out index entries representing the higher frequencies in the DFT's imaginary and real data arrays before combining and plotting them. The truncated DFT is then reverse transformed to yield what remains of the original data set. The reconstituted curve is plotted over the original curve and under the standard, filtered midline. Note how the ReverseDFT output converges on the mid line. This was expected, but gratifying anyway.

6. 
SAMPLE.mxg
DFT: 30.148 sec.
Filter: 0.492 sec.
RevDFT: 35.648 sec.
HighPass: 0.100 Hz
4.5
4
3.5
3
2.5
2
1.5
1
.5
%
Hz
-4
-3
-2
-1
0
1
2
3
4

7. 
SAMPLE.mxg
DFT: 30.211 sec.
Filter: 8.570 sec.
RevDFT: 35.148 sec.
HighPass: 2.000 Hz
4.5
4
3.5
3
2.5
2
1.5
1
.5
%
Hz
-4
-3
-2
-1
0
1
2
3
4



8.

Figures 6, 7, and 8. These examples reverse the filter operation to discard the lower frequency elements of the DFT. The ReverseDFT of this modified data, since it contains no DC offset, is nearly symmetric about the original data's horizontal axis (i.e. the 0% torque line). In order to view the entire reconstruction, its plot has been shifted upwards.

Allowing for the arbitrary vertical shift, it is fairly easy to see that adding the curve reconstituted from a high-pass filtered data set to the reconstructed data from a lowpass set using the same corner frequency would reproduce essentially the original curve.

Finally, note that once the primary DC components have been removed (figure 6), a great deal more of the DFT must be zeroed before any significant change appears in the AC components. This may be due to 'noise' being noise no matter how much of it is present. This is to say, that anything of real interest probably only occurs at the lower frequencies. Once they are eliminated we are stuck sifting through static.

It would be interesting to run the Fourier.PGM module against data collected on a synchronous sampling mixer. It would also be interesting to re-save a filtered curve and examine the plot at a 'magnified' horizontal and vertical scale to look for other data components. It is our expectation, however, that no other significant cyclic data is present.

```
; ****************************  FOURIER.PGM  ***************************
; ***********************************************************************
; * test DFT (Discrete Fourier transform) and reverse transform of data set
; * these procedures provide a frequency by amplitude snapshot of the data
; * and (after removing or altering the frequency components) allow
; * converting the filtered data back to the time*amplitude domain
; * (commonly refered to as the real world)
; * One application is to surgically remove the 'planetary pin motion'
; * component (at about 2.2 hz) of the raw data, affecting a highly
; * selective notch filter on the data.
; *
; * WRITTEN BY Alan E. Walker AEW Consulting
; * 07/12/2003 begun
; * 07/15/2003
; * 07/19/2003 discovered frequency plot is +/- freq/2 (not +/- freq)
;              so corrected all scaling-- this is curious
; * 12/23/2003 updated for inclusion in user's DOC.
; * 12/26/2003 made delete conditional for 'RealRegenHandle'
; * 04/28/2004 removed argument from initgraphscreen command
; *
; ***********************************************************************

[PRELOAD]
; PRE-ANALYSIS MODULE FOR SETTING UP CUSTOM MENUS AND VARIABLES

"PRELOAD" "STDINCL" INCLUDE

    HIDEALLUSERVAR
    "Find Peak" "boo" "UserVar0" WriteVarFmt
    "Peak Scanning Window (Hz)" "###.###" "UserVar1" writevarfmt
    "Enable Filter and ReverseDFT" "boo" "UserVar2" WriteVarFmt
    "Filter Type" "str|LowPass|HighPass" "UserVar3" WriteVarFmt
    "Corner Frequency" "###.###" "UserVar4" WriteVarFmt

; =====================================================================
[PROCS]

/FreqToIndex {
    ; freq FREQTOINDEX index  (clipped to 1--numpoints)
    ; for fourier frequency plots (-freq/2 to freq/2 maps to 1--numpoints)
    pushdict
    /index exch frequency 2 div add frequency div numpoints 1 sub mul 1 add
       def
    index 1 lt {/index 1 def} if ; clip to 1 or greater
    index numpoints gt {/index numpoints def} if ; clip to numpoints or less
    index ; return calculated index value via data stack
    popdict ; destroy local vars
} def

; ************************************

/ZeroDFTRange {
    ; freqstart freqend realhandle imaghandle maghandle ZERODFTRANGE -
    ; writes zeros to real, imaginary and magnitude tables
    ; over specified index range
    pushdict

    /maghandle exch def
    /imaghandle exch def
    /realhandle exch def
```

```
    /endindex exch freqtoindex def
    /startindex exch freqtoindex def

    startindex 1 endindex {
        /index exch def
        0 index realhandle arraywrite
        0 index imaghandle arraywrite
        0 index maghandle arraywrite
    } for

    popdict
} def

; ************************************

/FourierTest {
; sourcehandle cornerfreq passmode FOURIERTEST -
; passmode can be "LowPass" or "HighPass" only (case sensitive)
; cornerfreq is range limited to 0 -- mxg.frequency

/passmode exch def
/cornerfreq exch def
/SrcHandle exch def

initgraphscreen
1 0 numpoints 100 scalewindow
SrcHandle gray false 1 plotcurve

midhandle highgreen false 1 plotcurve

; generate Fourier transform on raw curve of loaded dataset
/elapsedtime timer def
SrcHandle DFT
/elapsedtime timer elapsedtime sub def
    /IMAGhandle exch def
    /REALhandle exch def

0 0 100 100 scalewindow ; for text work
"mxg.filename" readvar ".mxg" addstr
75 97 black screenwrite
"   DFT: " elapsedtime "###.###" format addstr " sec." addstr
75 93 highred screenwrite

/elapsedtime timer def
realhandle imaghandle rootsumsquare
/MAGhandle exch def

1 numpoints maghandle FINDMINMAX /plotmax exch def /plotmin exch def pop pop

enablefilter {
    passmode "HighPass" eq
        {cornerfreq chgsign cornerfreq realhandle imaghandle
          maghandle zerodftrange}
        {-999 cornerfreq chgsign realhandle imaghandle
          maghandle zerodftrange
          cornerfreq 999 realhandle imaghandle maghandle zerodftrange}
    ifelse

    /elapsedtime timer elapsedtime sub def
    0 0 100 100 scalewindow ; for text work
```

```
    "Filter: " elapsedtime "###.###" format addstr " sec." addstr
    75 89 highred screenwrite
} if

1 plotmin numpoints plotmax 20 div scalewindow
MAGhandle highred false 1 plotcurve

EnablePeak { 0
    "Select Peak to Evaluate (Left_Click to choose or Right_Click to Abort)"
    EDITGRAPHX
    {   /PeakTime exch def
        peaktime peakscanwindow 2 div frequency div numpoints mul sub
        peaktime peakscanwindow 2 div frequency div numpoints mul add
        maghandle FindMinMax pop pop exch pop
        /peaktime exch numpoints div 0.5 sub frequency mul def
        "  Peak: " PeakTime "###.###" format addstr " Hz." addstr
        0 0 100 100 scalewindow ; for text work
        75 77 highred screenwrite
    } if
} if


EnableFilter {
    ; generate ReverseFourier transform
    ; to recover (filtered) original data set
    /elapsedtime timer def
    realhandle imaghandle DFTreverse
    /elapsedtime timer elapsedtime sub def
    discardhandle ; imaginary component is assumed vestigal
    /REALregenhandle exch def
    0 0 100 100 scalewindow ; for text work
    "RevDFT: " elapsedtime "###.###" format addstr " sec." addstr
    75 85 highred screenwrite
    passmode ": " addstr cornerfreq "###.###" format addstr " Hz" addstr
    75 81 highred screenwrite

    passmode "HighPass" eq
        {1 -50 numpoints 50 scalewindow} ; high pass is mostly ac
        {1 0 numpoints 100 scalewindow} ; normal plot for low pass (mostly dc)
    ifelse
    realregenhandle highred false 1 plotcurve
} if

frequency 2 div chgsign dup chgsign "Hz" 0 5 "%" black false PLOTAXIS

1 0 numpoints 100 scalewindow
midhandle highgreen false 1 plotcurve ; rewrite filtered center line for ref.

; rename report to match special user settings
"mxg.filename" readvar " " addstr
enablefilter
    {cornerfreq "###.###" format addstr " hz " addstr
    passmode addstr }
    {"No Filter" addstr}
ifelse

"mxg.filename" writevar

imaghandle discardhandle
realhandle discardhandle
```

```
maghandle discardhandle
enablefilter {realregenhandle discardhandle} if
}def

; ============================================================================

[USER]

    clearstack
    packmem

"USER" "STDINCL" INCLUDE  ; INITIALIZATION FILE FOR STANDARD LIBRARY
"PROCS" "FOURIER" INCLUDE ; function library for this module

/EnablePeak "UserVar0" ReadVar def
/PeakScanWindow "UserVar1" ReadVar def
/EnableFilter "UserVar2" ReadVar def
/FilterType "UserVar3" ReadVar def
/CornerFreq "UserVar4" ReadVar def

    ; savevars ; cannot use as we want to override mxg.filename in analysis

    "" 3 rptwritedesc

    prehandle CornerFreq FilterType FourierTest

    ; restorevars

; ****************************************************************************
; ***************************** FOURIER.PGM ENDS *****************************
```

Chapter 19

STDINCL.PGM – The Standard .PGM Include Library

In developing a programming language which is so extensible, it is always difficult to decide how much functionality to put into the hard-coded core of the system and how much to add via external libraries. This module is the resulting compromise of that process.

STDINCL.PGM has three sub-modules.

The first section begins with the line '[PRELOAD]' found right after the authorship/purpose comment block. It contains tools used in setting up user menu choices and should be 'included' at the top of nearly all [PRELOAD] sections of user developed code.

Similarly, most user modules should 'include' the [USER] sub-section of this library at the top of their own .PGM file [USER] sub-sections.

The final part of this file, [BATCH], is the standard include for any MixSmart Batch File (.MBF) which will be reanalyzing .MXG data files.

The remainder of this chapter is the full listing of the STDINCL.PGM file:

```
; ****************************  STDINCL.PGM  ******************************
; ***************************************************************************
; * STANDARD EXTENSIONS LIBRARY FOR MIXSMART USER ANALYSES
; * WRITTEN BY Alan E. Walker/ AEW Consulting
; * LAST UPDATED
; * 02 MARCH     2003  beginning formal conversion to Windows MixSmart pgm
; * 19 April     2003  small updates for varius module conversions
; * 20 April     2003  added updates to batch functions
; * 26 July      2003  shifted uservar indexing from 1--10 to 0--9
; ***************************************************************************

[PRELOAD]


/HideAllUserVar { ; hide all UserVar0--9 user defined vars
              0 1 9 {"uservar" exch "str" ctype addstr "" dup 3 -1 roll
writevarfmt} for
            } def


; ***************************************************************************

[USER]

/CHGSIGN   { 0 EXCH SUB } DEF

/VAL       { "NUM" CTYPE } DEF

/STR       { "STR" CTYPE } DEF

/RIGHT     { ; str$ numchars RIGHT substr$
             PUSHDICT
             /NUMARG EXCH DEF
             /STRARG EXCH DEF
             STRARG STRARG LEN NUMARG SUB 1 ADD NUMARG MID
             POPDICT
           } DEF

; COLORS
/BLACK       0   0   0   rgb DEF
/LOWBLUE     0   0   128 rgb DEF
/LOWGREEN    0   128 0   rgb DEF
;/LOWCYAN      3 DEF
/LOWRED      128 0   0   rgb DEF
;/LOWMAGENTA   5 DEF
/LOWYELLOW  128 128 0   rgb DEF
;/BROWN        6 DEF
/GRAY        128 128 128 rgb DEF
/HIGHBLUE    0   0   255 rgb DEF
/HIGHGREEN   0   255 0   rgb DEF
; /HIGHCYAN    0   0   255 rgb def
/HIGHRED     255 0   0   rgb DEF
/HIGHMAGENTA 255 0   255 rgb DEF
/HIGHYELLOW  255 255 0   rgb DEF
/HIGHWHITE   255 255 255 rgb DEF

; ARRAY HANDLES
/RAWHANDLE         "raw" getdatasumhandle DEF
/PREHANDLE         "pre" getdatasumhandle DEF
```

```
/MIDHANDLE          "mid" getdatasumhandle DEF
/MIDAREAHANDLE      "midarea" getdatasumhandle DEF
/MIDSLOPEHANDLE     "midslope" getdatasumhandle DEF
/MIDSLOPE2HANDLE    "midslope2" getdatasumhandle DEF

/TOPHANDLE          "top" getdatasumhandle DEF
/TOPAREAHANDLE      "toparea" getdatasumhandle DEF
/TOPSLOPEHANDLE     "topslope" getdatasumhandle DEF
/TOPSLOPE2HANDLE    "topslope2" getdatasumhandle DEF

/BOTHANDLE          "bot" getdatasumhandle DEF
/BOTAREAHANDLE      "botarea" getdatasumhandle DEF
/BOTSLOPEHANDLE     "botslope" getdatasumhandle DEF
/BOTSLOPE2HANDLE    "botslope2" getdatasumhandle DEF

/FREQUENCY { "MXG.frequency" readvar } DEF

/PERIOD   { 1 FREQUENCY DIV } DEF

/RUNTIME  { "mxg.runtime" readvar } DEF

/TITLE    { "MXG.title" readvar } DEF

/MXGPATH  { "datapath" readvar } DEF

/DATADATE { "mxg.CollectionDate" readvar } DEF

/DATATIME { "mxg.CollectionTime" readvar } DEF

/MINUTESTOINDEX   {    ; CONVERT MINUTES VALUE TO TIME INDEX
             FREQUENCY MUL ; MULTIPLY BY SAMPLES PER SECOND
                           ; OF LOADED MXG FILE
             60 MUL        ; AND BY SECONDS PER MINUTE
           } DEF

/INDEXTOMINUTES   {    ; CONVERT TIME INDEX VALUE TO MINUTES
             FREQUENCY DIV ; DIVIDE BY SAMPLES PER SECOND
                           ; OF LOADED MXG FILE
             60 DIV        ; AND BY SECONDS PER MINUTE
           } DEF

/MINRD    { "mxg.minstdreading" readvar } DEF ; CALIBRATION MINIMUM DATA VALUE

/MAXRD    { "mxg.maxstdreading" readvar } DEF ; CALIBRATION MAXIMUM DATA VALUE

/MINSTD    { "mxg.minstdvalue" readvar } DEF   ; MINIMUM DISPLAYED PLOT VALUE
IS 0 %

/MAXSTD    { "mxg.maxstdvalue" readvar } DEF ; MAXIMUM DISPLAYED PLOT VALUE IS
100%

/NUMPOINTS { "mxg.numpoints" readvar } DEF

/RawToPercent { MINRD SUB MAXRD MINRD SUB DIV
                MAXSTD MINSTD SUB MUL
                MINSTD ADD
              } DEF

/ArrayPercentToRaw {
        ;  handle ArrayPercentToRaw
```

```
        ;  CONVERT AN ENTIRE SCALED DATA ARRAY TO RAW (INTEGER) VALUES
        ;  TYPICALLY TO ALLOW WRITING PROCESSED ARRAY BACK OUT TO .MXG FILE
        PUSHDICT
        /Handle EXCH DEF
        /CoeffA MAXRD MINRD SUB MAXSTD MINSTD SUB DIV DEF
        /Const  MINRD MINSTD CoeffA MUL SUB DEF
        CoeffA 0 Const 0 0 -32767 32767 Handle 0 HANDLE BLEND
        POPDICT
        } DEF

/ARRAYCOPY {  ; SRCANDLE DESTHANDLE ARRAYCOPY [DESTHANDLE]
              ; DESTHANDLE IS RETURNED FOR CREATED ARRAY IF DESTHANDLE INPUT
              ; IS ZERO, ELSE WRITE ARRAY COPY TO EXISTING DESTHANDLE

              PUSHDICT
              /DESTHANDLE EXCH DEF
              /SRCHANDLE EXCH DEF
              1 0 0 0 0 0 0 SRCHANDLE 0 DESTHANDLE BLEND
              POPDICT
           } DEF


; ***************************************************************************

[BATCH]

/analyzetrap {
               BatchRawHandle analyzemxg not {restorevars end} if
               "enableuseranalysis" readvar
               {
                 "user" "analyticalmodule" readvar include
               } if
               reportmxg not {restorevars end} if
               packmem
             } def

/load { 40 arrayinitall zeroallhandlevars
        "datapath" readvar ".mxg" 1
        loadmxg /BatchRawHandle exch def
      } def

/run { load
       analyzetrap
     } def

/alldone { "Batch file run Completed successfully."
           0
           "Finished: " "lastbatchname" readvar addstr ".MBF" addstr
           msgbox
         } def


; ***************************************************************************
; *************************  STDINCL.PGM ENDS ***************************
```

Chapter 20

A Partial Bibliography to Key Mixograph Literature

1. Bekes, F.; Gras, P.W. 1992. Demonstration of the 2-gram Mixograph as a research tool. Cereal Chemistry 69(2):229.

2. Buckley, D.J.; Lukow, O.M.; Lalonde, J.L.M.; Woods, S.M. 1990. A multilevel computer system for dough quality analysis and report distribution. Cereal Foods World 35:472.

3. Finney, K.F. 1989. A five-gram Mixograph to determine and predict functional properties of wheat flours. Cereal Chemistry 66:527.

4. Finney, K.F.; Shogren, M.D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Bakers Digest 46(2):32.

5. Gras, P.W.; Hibberd, G.E.; Walker, C.E. 1990. Electronic sensing and interpretation of dough properties using a 35-g Mixograph. Cereal Foods World 35:568.

6. Gras, P.W.; O'Bien, L. 1992. Application of a 2-gram Mixograph to early generation selection for dough strength. Cereal Chemistry 69(3):254.

7. Hazelton, J.L.; Chung, O.K.; Eastman, J.J.; Lang, C.E.; McCluskey. P.J.; Miller, R.A.; Shipman, M.A.; and Walker, C.E. 1997. Regression equation for predicting absorption for 2-g direct drive Mixograph. Cereal Chemistry 74(4):400.

8. Hazelton, J.L.; Walker, C.E. 1996. Changing mixogram appearance by sampling at fixed as opposed to random head position. Cereal Foods World 41(7):631.

9. Hazelton, J.L.; Walker, C.E. 1995. Sample frequency effects on mixograms. Cereal Chemistry 72(4):368.

10. Hazelton, J.L., Walker, C.E. 1994. Changing in mixograms resulting from variations in shear caused by different bowl pin sizes. Cereal Chemistry 71(6):632.

11. Ingelin, M.E.; Lukow, O.M. 1999. Mixograph absorption determination by response surface methodology. Cereal Chemistry 76(1):9.

12. Lang, C. E.; Neises, E. K.; Walker, C. E. 1992. Effects of additives on flour-water mixograms. Cereal Chemistry 69:587.

13. Li, A.; Walker, C.E. 1992. Dough temperature changes during mixing in a Mixograph. Cereal Chemistry 69(6):681.

14. Martinant, J.P.; Nicolas, Y.; Bouguennec, A.; Popineau, Y.; Saulnier, L.; Branlard, G. 1998. Relationships between Mixograph parameters and indices of wheat grain quality. Journal of Cereal Science 27(2):179.

15. Navickis, L.L.; Rubenthaler, G.S.; Nelson, T.C.; Butterfield, R.O. 1990. Evaluating Mixogram parameters by electronic torque sensing. Cereal Foods World 35:493.

16. Navickis, L.L.; Butterfield, R.O.; Nelson, T.C. 1989. A modified electronic torsion sensor for a 10-gram Mixograph with computerized data acquisition and analysis. Cereal Chemistry 66:350.

17. Neufeld, K.J.; Walker, C.E. 1990. Evaluation of commercial wheat gluten using the Mixograph. Cereal Foods World 35:667.

18. Rath, C.R.; Gras, P.W.; Wrigley, C.W.; Walker, C.E. 1990. Evaluation of dough properties from two grams of flour using the Mixograph principle. Cereal Foods World 35(6):572.

19. Rubenthaler, G.L.; King, G.E. 1986. Computer characterization of mixograms and their relationship to baking performance, in Fundamentals of Dough Rheology, Faridi, H. and Faubion, J.M., Eds. A.A.C.C., St. Paul.

20. Shelke, K.; Walker, C.E. 1990. A water jacketed bowl for Mixograph temperature control. Cereal Foods World 35:575.

21. Shelton, D.R. 1990. Digital processing of Mixograph curves. Cereal Foods World 35:486.

22. Shogren, M.D. 1990. The Mixograph-a Historical Perspective of an Instrument with a Promising Future. Department of Grain Science and Industry, Kansas State University, Manhattan, KS 66506-2201.

23. Stearns, M.; Barta, S. 1990. Mixograph standardization/digital data acquisition. Cereal Foods World 35:485.

24. Steele, J.L.; Brabec, D.C.; Walker, D.E. 1990. Mixograph instrumentation for moving bowl and fixed bowl comparison of wheat flour performance. Proceedings of Food Processing Automation Conference. Lexington, KY, ASAE Publication 02-90, P. 224.

25. Suchy, J.; Lokow, O.M.; Ingelin, M.E. 2000. Dough microextensibility method using a 2-g Mixograph and a texture analyzer. Cereal Chemistry 77(1):39.

26. Swanson, C.O.; Working, E.B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chemistry 10:1.

27. Vidal, R.L.; Walker, C.E. 1990. Absorption and RPM effects on mixing parameters by the Australian 2-gram direct drive recording dough mixer. Cereal Foods World 35:823. (Abstract)

28. Voisey, P.W.; Miller, H.; Kloek, M. 1966. An electronic recording dough mixer. Cereal Chemistry 43:408.

29. Walker, C.E.; Hazelton, J.L. 1996. Dough rheological tests. Cereal Foods World 41(1):23.

30. Walker, C. E.; Walker, A. E. 1990. Mixograph data acquisition and analysis by personal computer. Cereal Foods World 35:823. (Abstract)

31. Wikstrom, K.; Bohlin, L. 1996. Multivariate analysis as a tool to predict bread volume from mixogram parameters. Cereal Chemistry 73(6):686.

32. Wooding, A.R.; Walker, C.E. 1992. Comparison of alternative recording mechanisms (mobile vs. fixed bowl) for the 35- and 10- gram Mixographs. Cereal Chemistry 69:249.

Chapter 21

Absorption Research Paper: 'A Regression Equation…'

This chapter contains an original research paper concerning work done at Kansas State University. It provides the analytical background to the predictive equations used in the ABSPRED.PGM program module described in section 18.2.

A Regression Equation to Predict Absorption for the 10g and 35g Mixograph©[1]

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[4]AEW Consulting, 1636 "O" St., Lincoln, NE 68508-1633. Phone: +1(402)474-2199

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Published as contribution no. 98-299-J, Kansas Agricultural Experiment Station.

21.1 Introduction

The Mixograph© is often used to characterize a flour's mixing and absorption characteristics. The instrument is often used by plant breeders because it requires as little as 2 g of flour. Unfortunately however, many Mixograph users have had difficulty in predicting flour optimum absorption, and it has been described as a "touchy-feely" process that requires much practice. Studies have shown that protein quality and quantity (Finney 1945, Finney and Shogren 1972), and temperature (Shelke and Walker 1990) among many other things all play important roles in flour absorption. Various approaches to determining Mixograph absorption have included using a fixed absorption, using an absorption based on flour moisture and protein (Finney 1945), and adjusting absorption based on one or more trial curves, time consuming and a problem when sample size is limited. Although Mixogram data can be assessed by either manual or computerized methods, the underlying basis for analysis is still the same. The operator subjectively determines flour optimum absorption by looking for certain attributes, including the amount of sway in the ascending curve, the band width and its uniformity, and curve heights at various points along the Mixogram (Swanson and Johnson 1943, Finney and Shogren 1972). Studies have shown that protein, variety, and temperature all play important roles in determining absorption.

Under uniform conditions in any one laboratory, an experienced operator can develop a good level of replication. However, the variability is high in inter-laboratory collaborative work (Kunerth and D'Appolonia 1985). A previous project developed a multiple regression equation to predict flour optimum water absorption for the direct-drive 2g-mixograph (Hazelton et al. 1997). The regression equation ascertains whether the initial or trial absorption was correct and, if not, predicts how it could be corrected.

The objective of this study was to develop a flour water absorption prediction equation for the 10g and 35g moving bowl Mixographs. This equation would be derived by comparing subjectively determined water absorptions from several scientists partaking in a collaborative study. Proper absorption determination could than be based on flour moisture and protein contents, adjusted by the results from a single (10 min) trial with the conventional moving bowl Mixograph.

21.2 Materials and Methods

This was a collaborative study in which eight wheat flour samples (Table 1) with various mixing characteristics were collected from several sources throughout the US. Their protein contents ranged from 10.16 to 16.34%. Flour moisture and protein were used to calculate a starting absorption,

where % abs = 1.5 (% protein) + 43.6 (Finney 1945 and AACC 1996). All analyses, weights, and calculations were on a 14% moisture basis.

Collaborators were sent 10 flour samples (including 2 blind duplicates) and detailed instructions. To avoid bias, only starting amounts of flour and water were provided. The collaborators were asked to first run one Mixogram using the indicated flour and water amounts. They were asked to then run two additional Mixograms at their discretion (either increasing or decreasing the amount of water) to achieve 'optimum' absorption. Both 10g and 35g moving bowl Mixographs were included in this study. Mixograms were collected in a digitized format or recorded by the conventional strip chart and later scanned to produce a digitized file (Shelton 1990; Mixscan© software, AEW Consulting, Lincoln, NE). Fourteen Mixogram sets resulted in 420 Mixograms across all operators.

Standardization Procedures
The standard Mixograph Method, 54-40A, modified only to accommodate the computerized format was used (AACC 1996). Collaborators were asked to verify the pin clearance (0.034 in.) between the head pins and bowl bottom. They also were asked to check that the position of the recording pen was centered on the paper and the damping-arm stops were adjusted so that the pen range was between the bottom and top lines and to place the spring in the #12 position of the spring-tension-index bar. Other instructions included warming up the Mixograph for 30 min prior to testing; weighing samples and measuring absorption water to 0.01g and 0.01ml, respectively; maintaining testing conditions at 25±1°C, and running each Mixogram for 10 min.

Statistical Analyses
Approximately 40 different mixing parameters were automatically derived from each curve and were considered in developing the equation (Hazelton et al. 1997; Mixsmart software, National Mfg., Lincoln, NE). One-way analysis of variance (ANOVA) was used to assess differences among flours and collaborators. In order to reduce the initial number of parameters, correlation analysis and stepwise multiple regression were conducted to select those that contributed the most to the absorption effect (SAS ver 6.11, SAS Institute Inc., NC). Interactions and squared terms for each parameter also were tested.

21.3 Results and Discussion

As intended, the 10 flour samples showed significant differences in mixing parameters. No significant differences in peak time and height were observed among collaborators for the starting absorption, but differences did occur for peak width (Table 2). These differences in peak width might be attributed to mechanical and temperature variations rather than to operators, per se.

As expected, most collaborators tended to consistently run either drier or wetter Mixograms when compared to each other (Tables 1 & 2). Such preferences constitute the underlying problem in determining a universally "optimum" Mixograph absorption. Although the average “change from starting” between the starting and collaborator-selected absorptions, averaged across all collaborators, for the flours were small, there was a great range across the collaborators (Table 1). The collaborators' preferences for dryer or wetter doughs are reflected in Table 2 by the “averaged selected absorption adjustment” ranging from –4.0 to +9.8% across all flours tested. We should note that the operator's preference could be compensated for in the equation by simply adding the selected absorption adjustment to the following equation's first-term constant.

An equation was developed for predicting the absorption adjustment by multiple regression. It predicts a percent absorption adjustment (% Abs Adj) necessary to correct the starting absorption, thus providing the recommended Mixograph absorption. (All measurements from the Mixogram mid-line curve unless otherwise noted.)

The original equation contained 11 terms with 8 Mixogram variables and accounted for 66% of the variability in absorption. By examining the relative magnitude of the contributions from the previously selected factors it was possible to reduce the equation to 7 terms in 5 variables and still account for 62% of the absorption variability. The revised equation is reported below.

Although care must be taken to avoid confusing ‘correlation’ with ‘cause & effect’, the terms finally chosen for their mathematical contributions do also reflect the curve features usually observed by operators when judging a Mixograph curve for proper absorption. Wide ascending curves and at peak often indicate “too dry”. An ascending curve’s convex ‘sway’ indicates too wet and a convex curve indicates too dry. The Right-of Peak integral is a ‘work’ term & indicates how stiff the dough is. The height of the curve at the tail indicates stability; too much water causes it to fall rapidly.

$$\%\ \text{Abs Adj} = 28.611 - 59.794(A) + 12.177(A)^2 - 0.008(B)^2 + 0.00006(C)^2 + 0.843(A)(D) + 0.004(D)(E)$$

Where,

A = width ratio (band width at peak time / width at 55%-of-peak time)

B = left of peak height (1 minute prior to peak)

C = right-of-peak integral

D = height at 55%-of-peak time

E = tail height (10 minutes)

The equation was developed with wheat flours ranging from 10.16 to 16.34% protein. About 62% of the variability (i.e., r^2 = 0.62) in % Absorption Adjustment is accounted for by the value obtained from the starting absorption as predicted by Finney (1945). Analysis of variance for the multiple regression equation yielded an *F* value of 105.6 and significant probability of 0.0001. The equation was validated by running Mixograms on another 9 wheat flours from a subsequent crop year and representing different commercial sources. Their protein contents ranged from 9.43 to 13.64%. The flours did not exactly fit the water absorption equation. However, by adjusting the first constant, the equation provided a satisfactory fit. This illustrates adjusting the equation for crop year & laboratory preferences.

21.4 Conclusions

The absorption adjustments, averaged across all ten flours, ranged from –3.9 to +9.8 across the 14 cooperators, or 13.7% from those preferring the driest to the wettest doughs (Table 2). When the ten flours were averaged across operators, (Table 1) the spread in values selected for each flour ranged from 8.0% to 19.0% as opposed to the 9.3% starting range across all flours as predicted from the moisture/protein equation. That is, although these flours represented a wide range in properties, there was more variability in the values selected for any given flour by the different operators than there was among the flours themselves.

This objective method could allow for comparisons among laboratories, operators, and machine configurations (moving- or fixed-bowl and direct-drive). Although preferences cause differences between operators, the equation still provides a basis from which Mixograph absorption can be predicted. Only an adjustment to the equation's first-term constant is required for "dry" or "wet" preferences. The equation could be useful for routine Mixograph analysis, especially by plant breeders testing samples with limited amounts of flour available.

To use the equation, an operator would run a Mixogram with the starting absorption based upon the moisture/protein calculation. If the recommended adjustment were no more than ± 3%, then the adjusted value could be noted as "correct." If the recommended adjustment were more than 3%, another Mixogram should be run with the newly recommended absorption adjustment. Do not run a third trial. Experience by many operators over many years has shown that about $\pm$2% absorption differences are the smallest that can be detected reliably by conventional methods.

The operator must remain alert however to 'non-typical' curves that can cause the regression equation to recommend wildly false adjustments. It is still not

possible to objectively predict proper absorption by strictly mathematical methods in all cases.

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21.6 Literature Cited

American Association of Cereal Chemists. 1996. Approved Methods of the AACC, 9th ed. Method 54-40A, approved 4-61, revised 10-88. The Association: St. Paul, MN.

Finney, K. F. 1945. Methods of estimating and effects of variety and protein content level on the baking quality of flour. Cereal Chem. 22:149-160.

Finney, K. F. and Shogren, M. D. 1972. A ten-gram mixograph for determining and predicting functional properties of wheat flours. Baker's Digest 46:32-42, 77.

Hazelton, J. L., Chung, O. K., Eastman, J. J., Lang, C. E., McCluskey, P. J., Miller, R. A., Shipman, M. A., and Walker, C. E. 1997. A regression equation for predicting absorption for the 2-gram direct drive mixograph. Cereal Chem. 74(4):400.

Kunerth, W. H. and D'Appolonia, B. L. 1985. Use of the mixograph and farinograph in wheat quality evaluation. Pages 27-49 in: Rheology of Wheat Products. H. Faridi, ed. Am. Assoc. Cereal Chem.: St. Paul, MN.

Shelke, K. and Walker, C. E. 1990. A water-jacketed bowl for mixograph temperature control. Cereal Foods World 35(6):575.

Shelton, D. R. 1990. Digital processing of mixograph curves. Cereal Foods World 35(5):486.

Swanson, C. O. and Johnson, J. A. 1943. Description of mixograms. Cereal Chem. 20:39.

TABLE 1

Starting and Collaborator-selected Mixograph Absorptions

Flour	Ash* (%)	Protein* (%)	Starting ** Abs	Collaborator Selected Abs*** Range	Collaborator Selected Abs*** Average	Change from Starting
1	0.499	16.34	68.1	64.1 – 80.1 (16.0)	68.5	0.4
2	0.537	14.58	65.5	63.5 – 77.5 (14.0)	67.1	1.6
3	0.537	14.58	65.5	63.0 – 79.5 (16.5)	66.6	1.1
4	0.564	12.74	62.7	58.7 – 66.7 (8.0)	61.3	-1.4
5	0.398	12.31	62.1	58.1 – 72.1 (14.0)	62.5	0.4
6	0.338	11.94	61.5	56.0 – 73.0 (17.0)	61.6	0.1
7	0.544	11.91	61.5	56.0 - 65.5 (9.5)	59.6	-1.9
8	0.544	11.91	61.5	57.0 - 71.5 (14.5)	60.5	-1.0
9	0.462	11.43	60.7	52.2 – 71.2 (19.0)	58.1	-2.6
10	0.347	10.16	58.8	43.8 - 62.8 (19.0)	53.5	-5.4

* based on 14% mb

**Based on protein at 14% mb, where %Abs = 1.5(protein) + 43.6, and adjusted for moisture content.

Flours #2 & #3 and #7 & #8 were blind duplicates

***Note huge ranges in collaborator selected values for any given flour.

TABLE 2

Single Factor Analysis Across Ten Flour Samples

	Selected Abs. Adj.*		Peak Time		Peak Height		Peak Width	
Collaborator	Average	S. D.	Average	S. D.	Average	S. D.	Average	S. D.
A	0.0	0.93	3.99	1.40	43.35	8.20	19.07	6.09
B	-0.4	1.15	3.71	1.40	44.55	6.54	17.62	3.41
C	3.0	1.22	3.95	1.46	45.61	8.19	20.57	6.61
D	-1.2	1.38	3.94	1.22	47.61	6.20	23.47	6.44
E	-1.0	1.22	3.80	1.25	42.24	7.11	13.59	3.43
F	-0.5	1.88	3.33	1.14	47.33	7.92	26.82	6.69
G	-1.9	1.17	3.65	1.13	45.77	7.60	17.57	5.43
H	-3.9	1.49	3.72	1.21	48.28	8.01	19.58	5.90
I	-2.8	1.57	3.66	1.20	51.09	7.62	20.69	5.34
J	9.8	1.93	4.01	1.43	42.50	7.00	14.43	3.80
K	-1.8	1.72	3.58	1.34	46.99	9.32	27.46	10.33
L	-0.1	1.89	4.05	1.35	48.75	8.11	22.42	5.39
M	-1.6	1.29	3.74	1.13	48.39	7.85	21.02	5.70
N	-4.0	1.32	3.59	1.14	44.07	7.44	19.20	4.86
Mean	-0.5	1.44	3.77		46.18		20.25	
S. D.	3.44	0.31	0.203		2.612		3.984	
F crit	----		1.799		1.799		1.799	
F	----		0.254		1.155		4.540	

* Selected absorption adjusted from the starting absorption.

alpha=.05